US011370574B2

(12) **United States Patent**
Eichenberger et al.

(10) **Patent No.: US 11,370,574 B2**
(45) **Date of Patent: Jun. 28, 2022**

(54) **APPLICATOR APPARATUS AND METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/298,532**

(22) PCT Filed: **Nov. 29, 2019**

(86) PCT No.: **PCT/EP2019/083133**
§ 371 (c)(1),
(2) Date: **May 28, 2021**

(87) PCT Pub. No.: **WO2020/109575**
PCT Pub. Date: **Jun. 4, 2020**

(65) **Prior Publication Data**

US 2022/0009664 A1 Jan. 13, 2022

(30) **Foreign Application Priority Data**

Nov. 30, 2018 (GB) 1819602

(51) **Int. Cl.**
B32B 41/00 (2006.01)
B65C 9/36 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B65C 9/36*** (2013.01); ***B65C 9/1876*** (2013.01); ***B65C 9/28*** (2013.01); ***B65C 9/40*** (2013.01)

(58) **Field of Classification Search**
CPC B65C 9/36; B65C 9/1876; B65C 9/28; B65C 9/40
(Continued)

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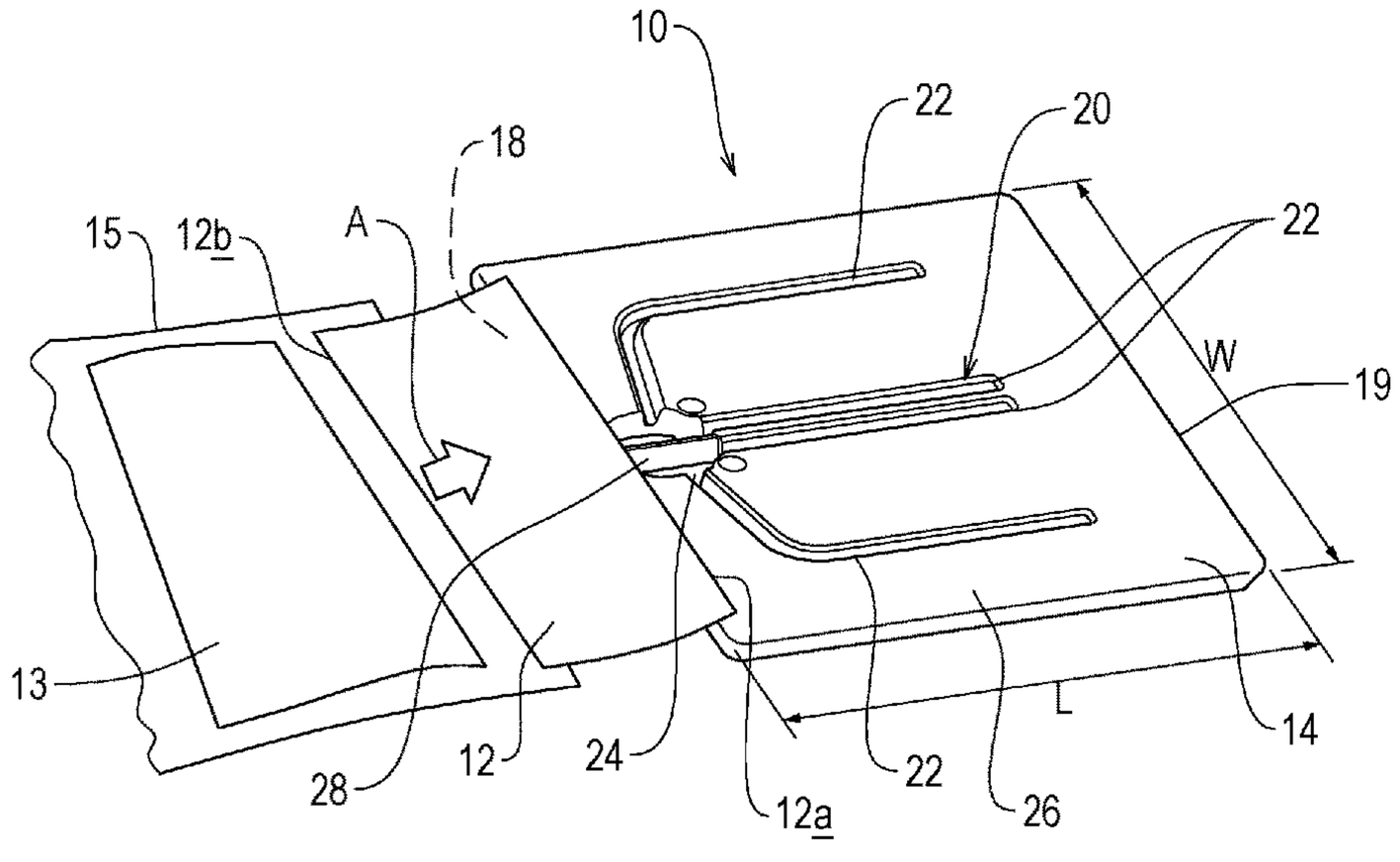
(57) **ABSTRACT**

An applicator apparatus including an applicator pad (**10**) and an actuator (**180**) for positioning the applicator pad (**10**) in a desired position, the applicator pad (**10**) being attached to the actuator (**180**) by an attachment member (**40**), wherein the attachment member (**40**) enables articulation between the applicator pad (**10**) and the actuator (**180**).

22 Claims, 11 Drawing Sheets



(51) **Int. Cl.**
B65C 9/18 (2006.01)
B65C 9/28 (2006.01)
B65C 9/40 (2006.01)

(58) **Field of Classification Search**
USPC 156/60, 64, 350, 351, 378, 379
See application file for complete search history.

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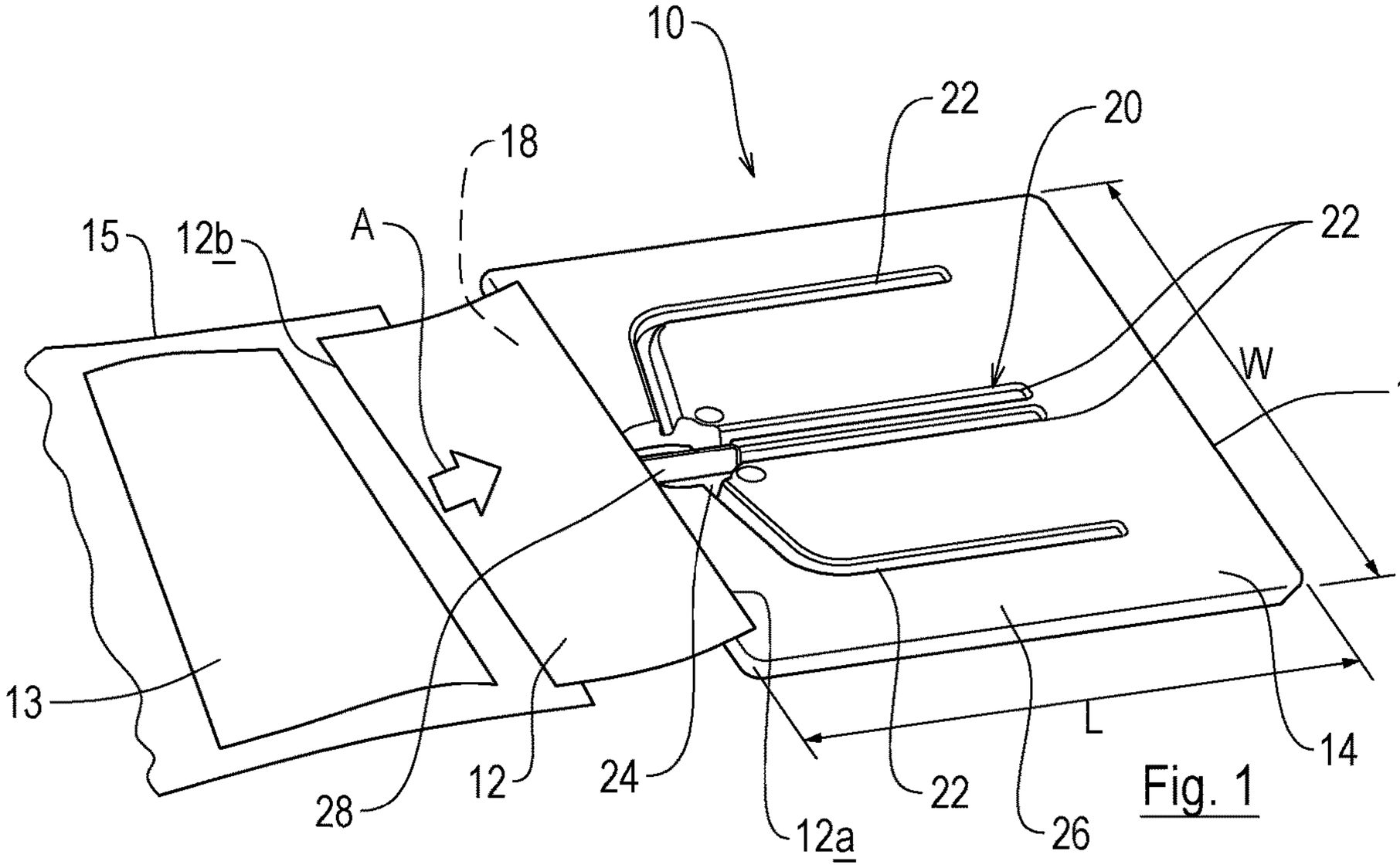


Fig. 1

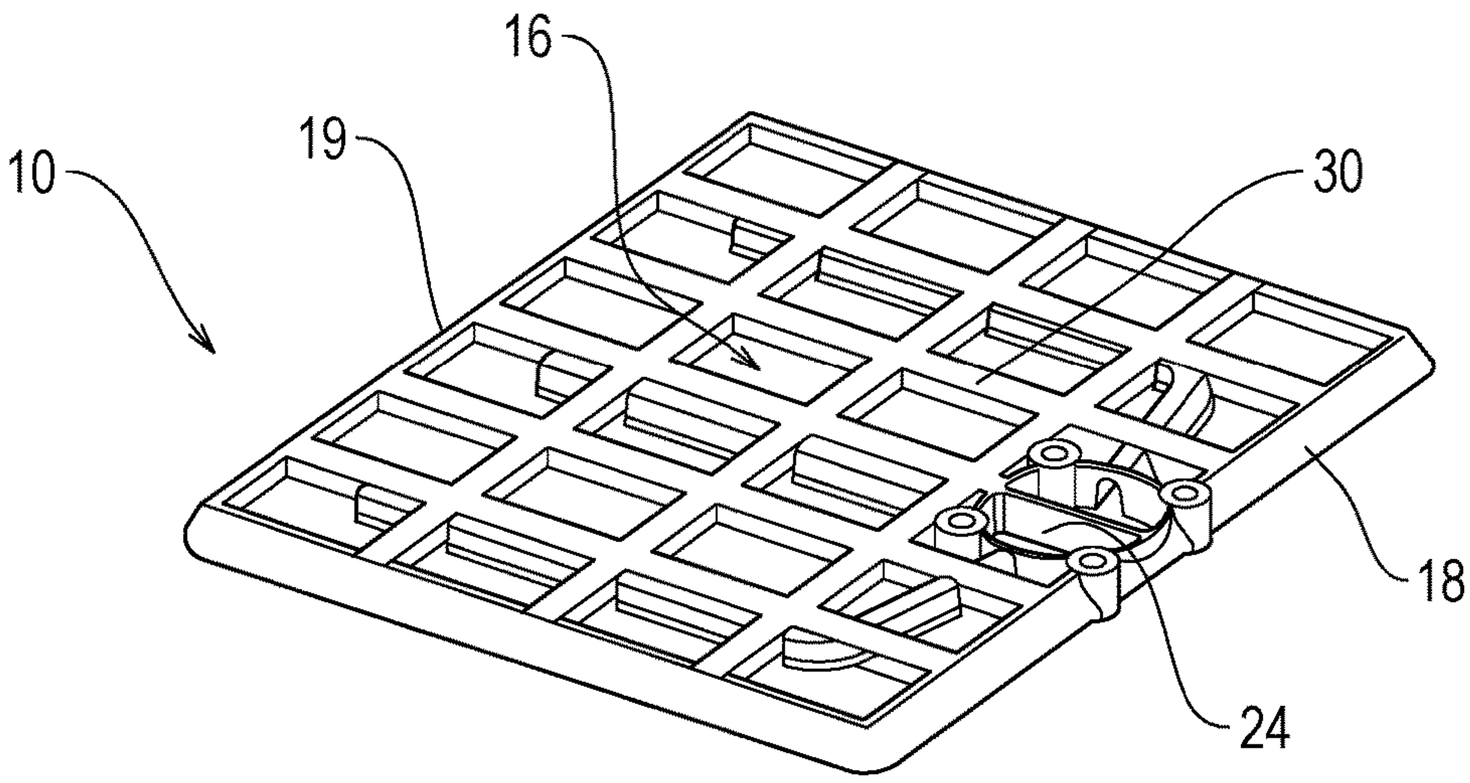


Fig. 2

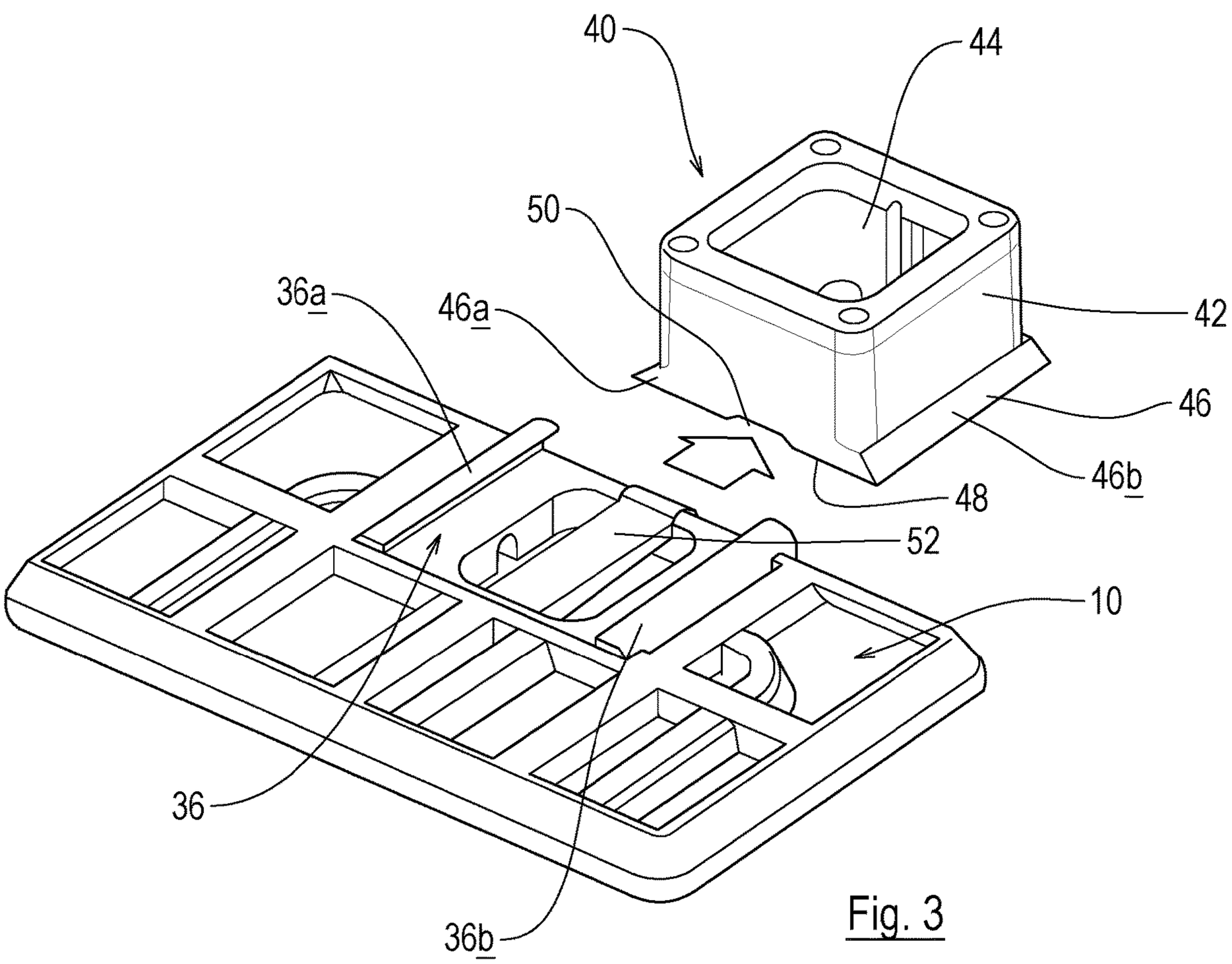


Fig. 3

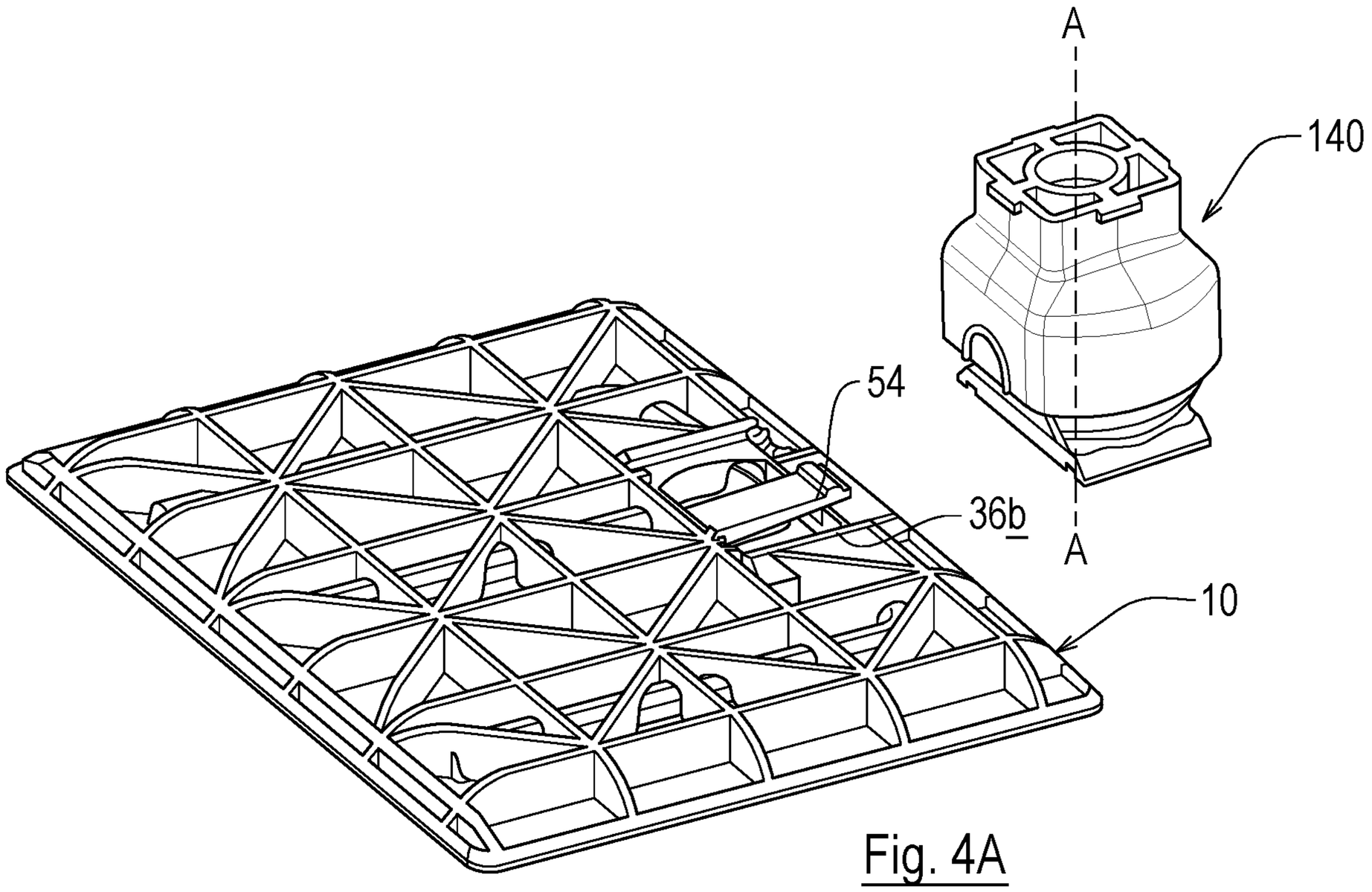
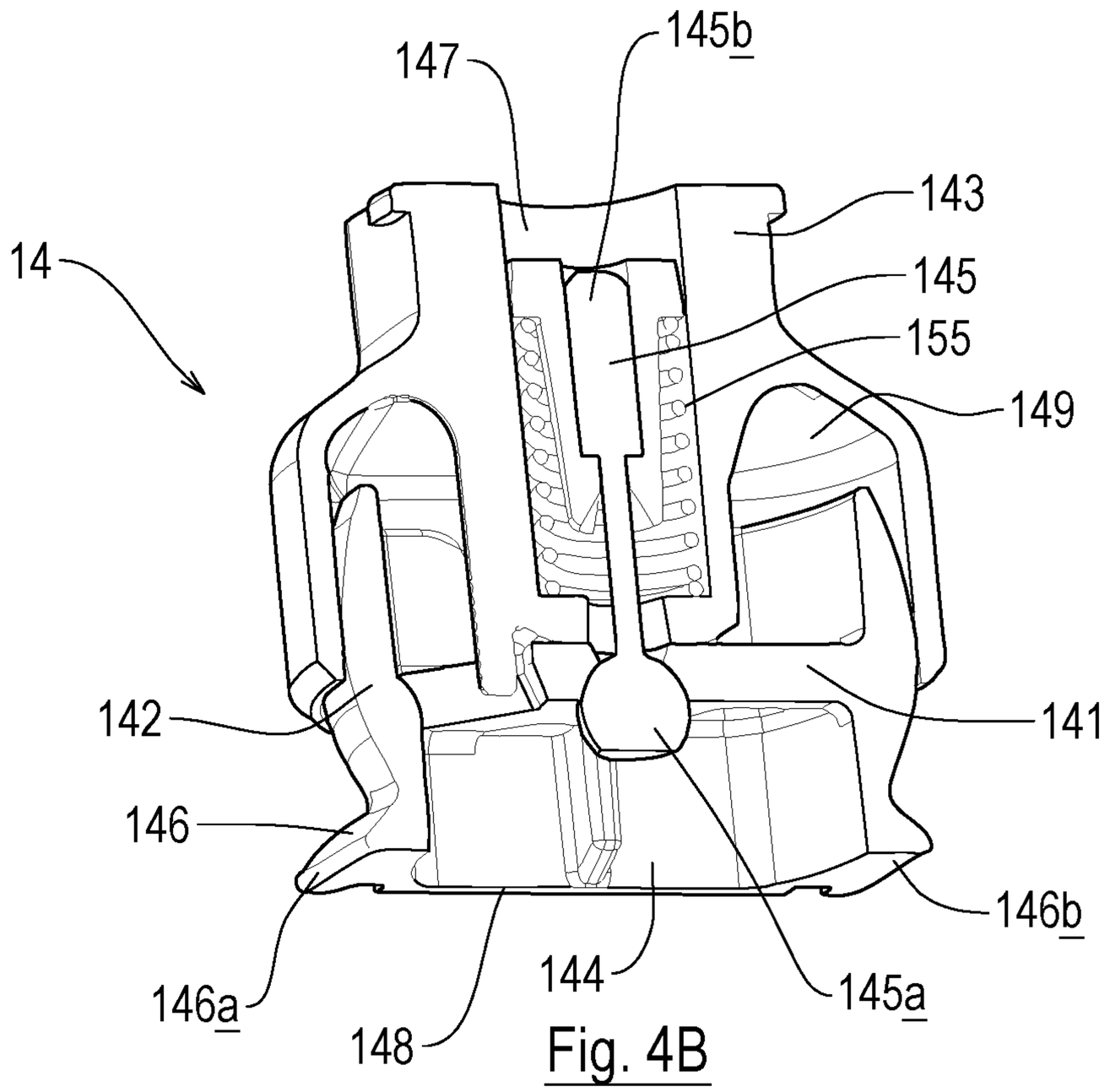

A
140
54
36b
A
10

Fig. 4A


147
145b
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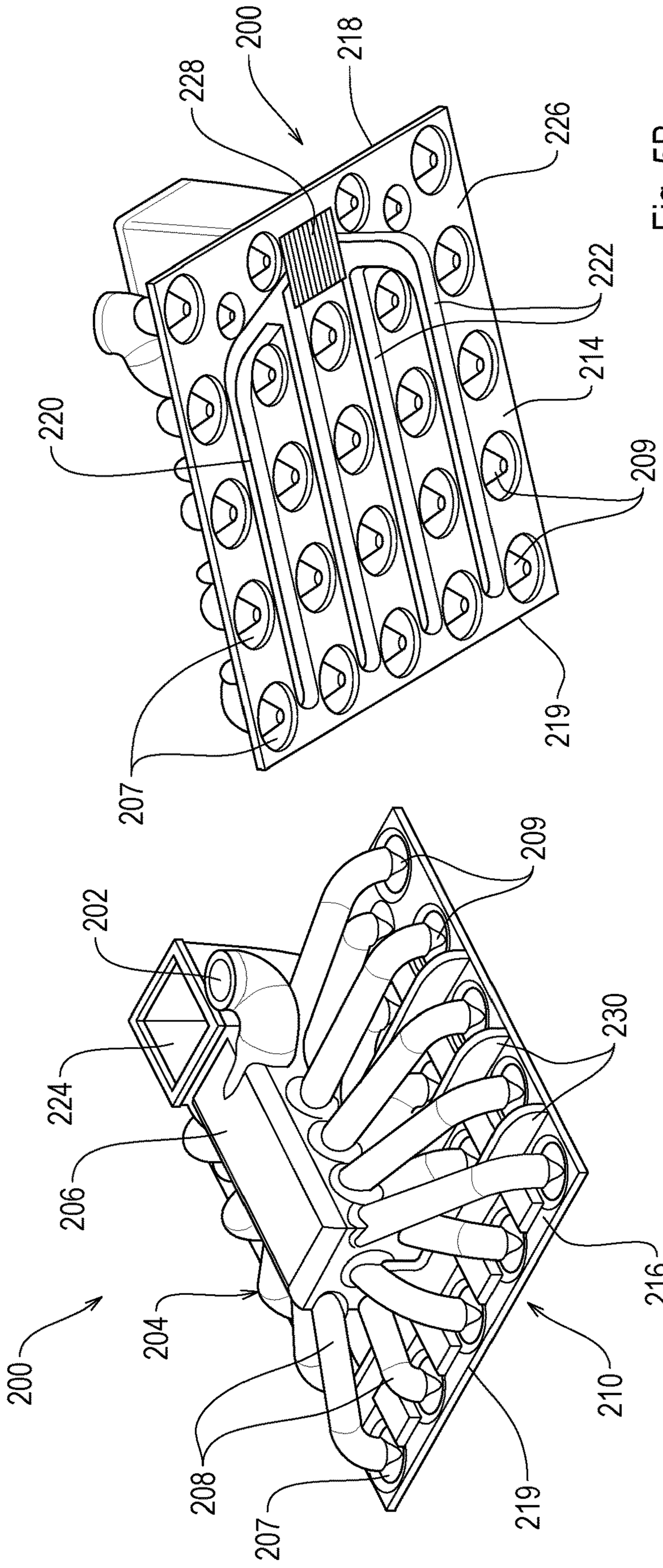
145
155
149
142
141
146
146b
144
146a
145a
148

Fig. 4B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200
218
226
222
214
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209
207
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202
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230
224
206
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204
208
207
219
210

Fig. 5A

Fig. 5B

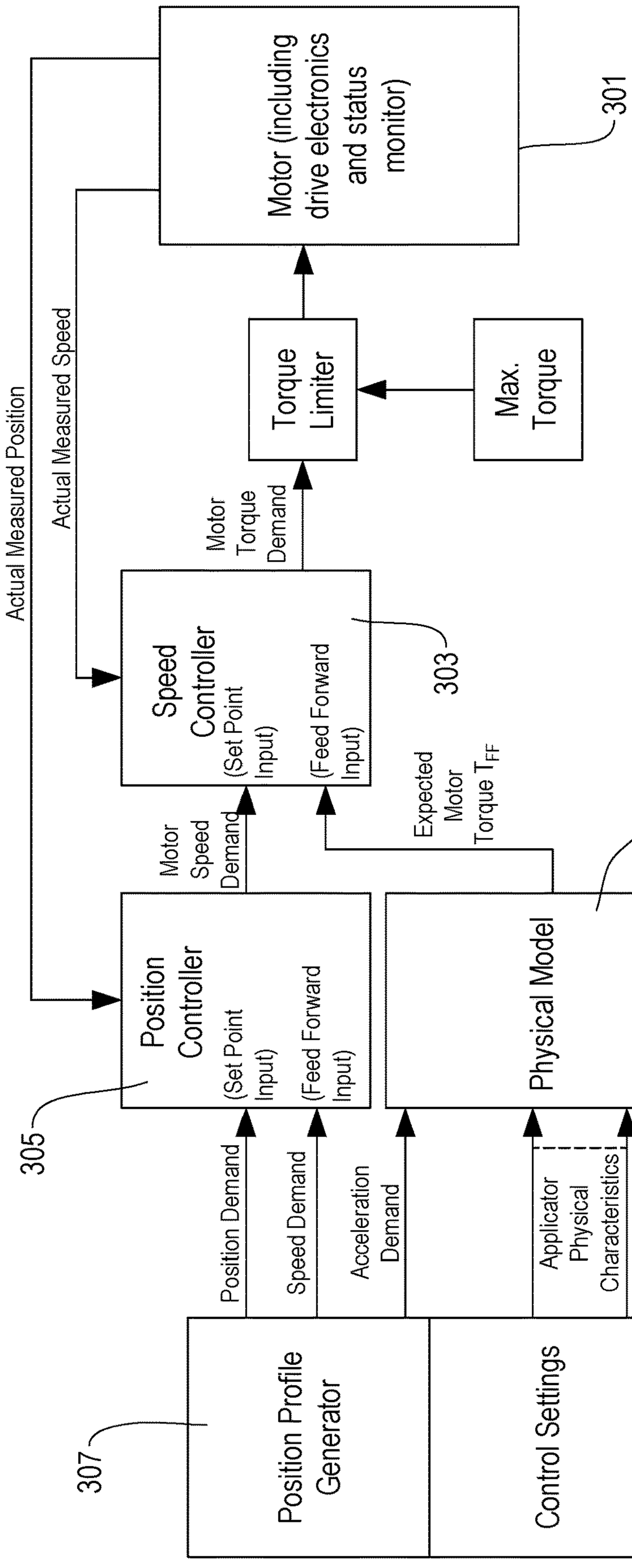
Motor (including drive electronics and status monitor)
301
Torque Limiter
Max. Torque
Actual Measured Position
Actual Measured Speed
Speed Controller
(Set Point Input)
(Feed Forward Input)
Motor Torque Demand
303
Expected Motor Torque T_{FF}
308
309
Position Controller
(Set Point Input)
(Feed Forward Input)
Motor Speed Demand
Physical Model
Applicator Orientation Sensor
305
Position Demand
Speed Demand
Acceleration Demand
Applicator Physical Characteristics
307
Position Profile Generator
Control Settings

Fig. 6

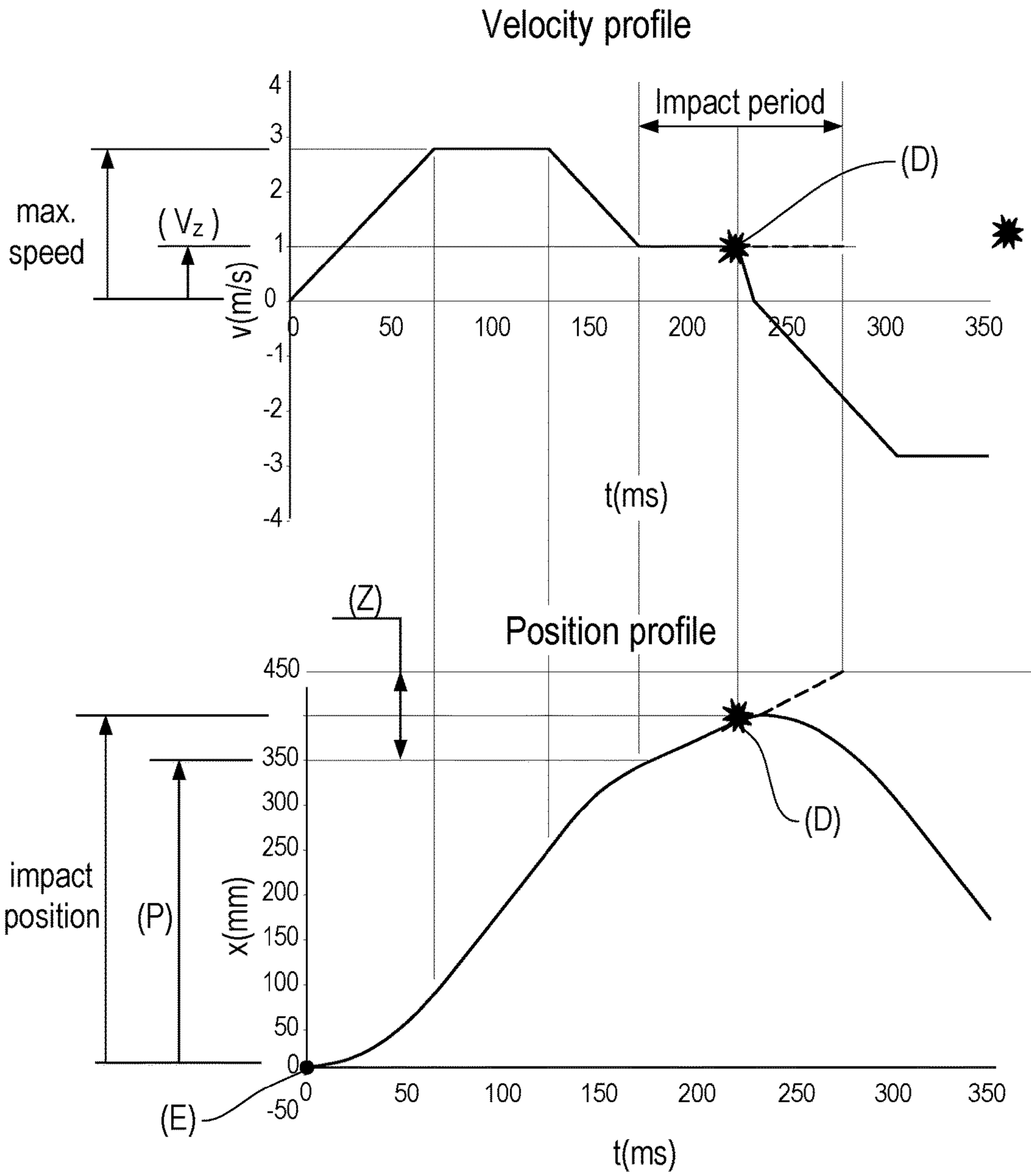
Velocity profile
Impact period
(D)
max. speed
(Vz)
v(m/s)
4
3
2
1
0
-1
-2
-3
-4
0
50
100
150
200
250
300
350
t(ms)
(Z)
Position profile
450
350
300
250
200
150
100
50
0
-50
impact position
(P)
x(mm)
(D)
(E)
0
50
100
150
200
250
300
350
t(ms)

Fig. 7

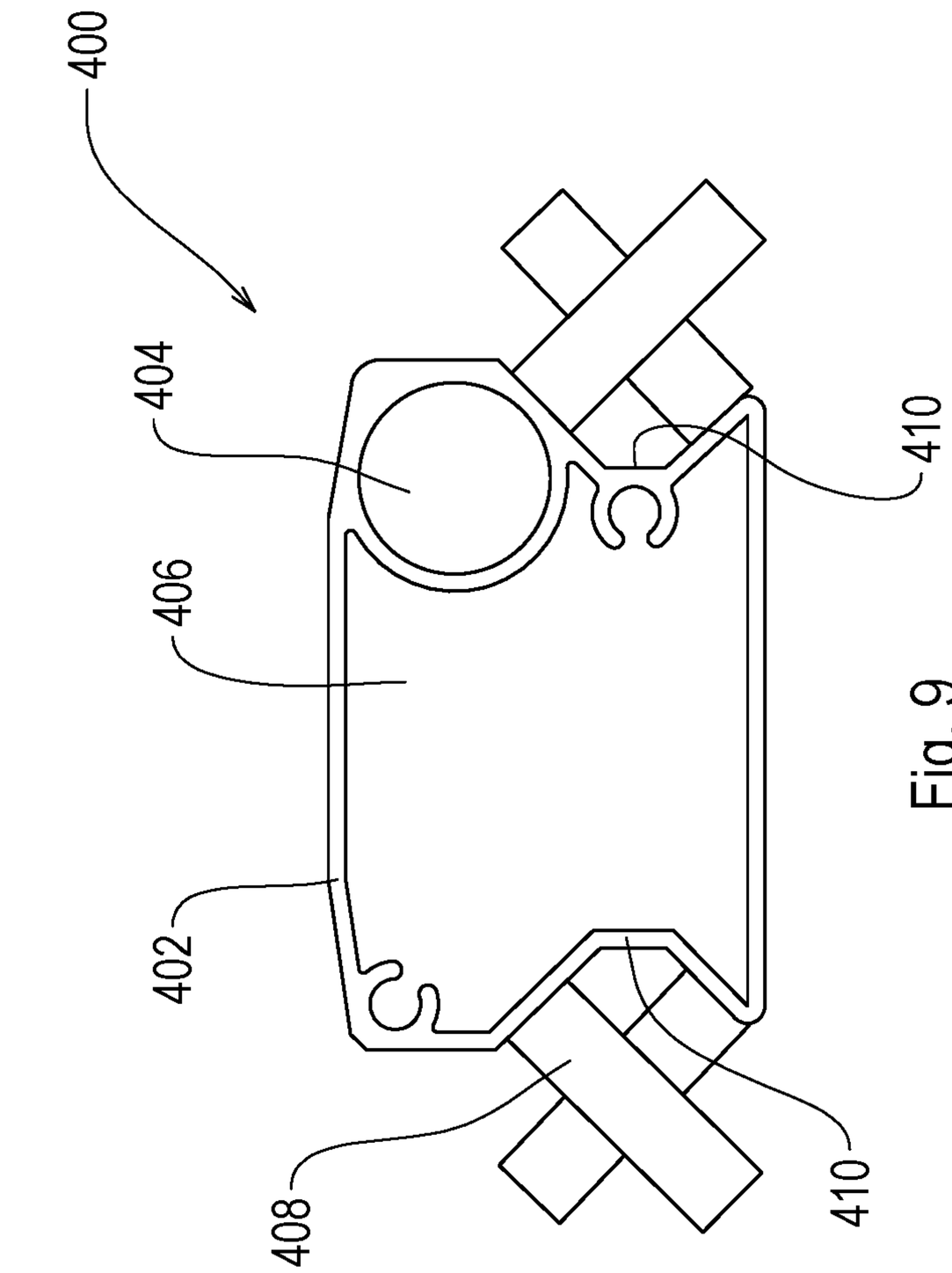

Fig. 9

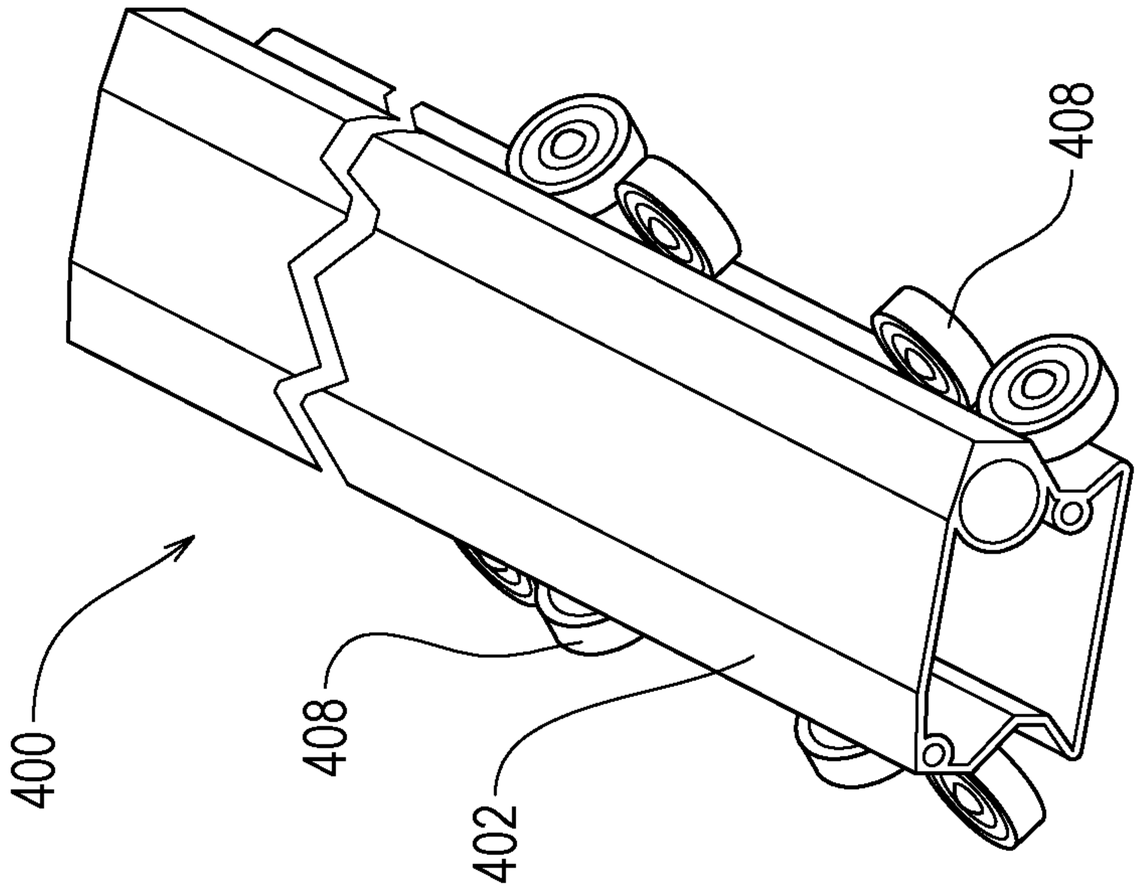

Fig. 8

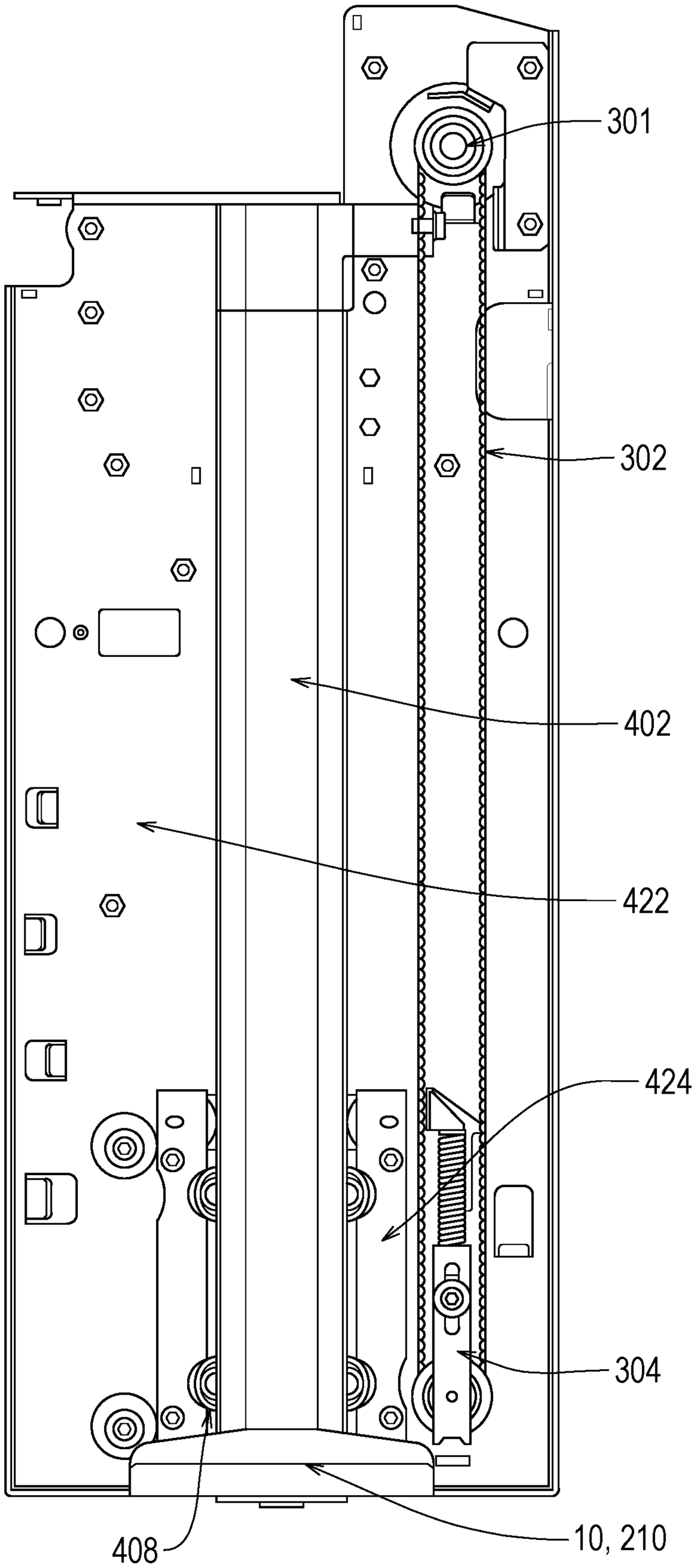

Fig. 10

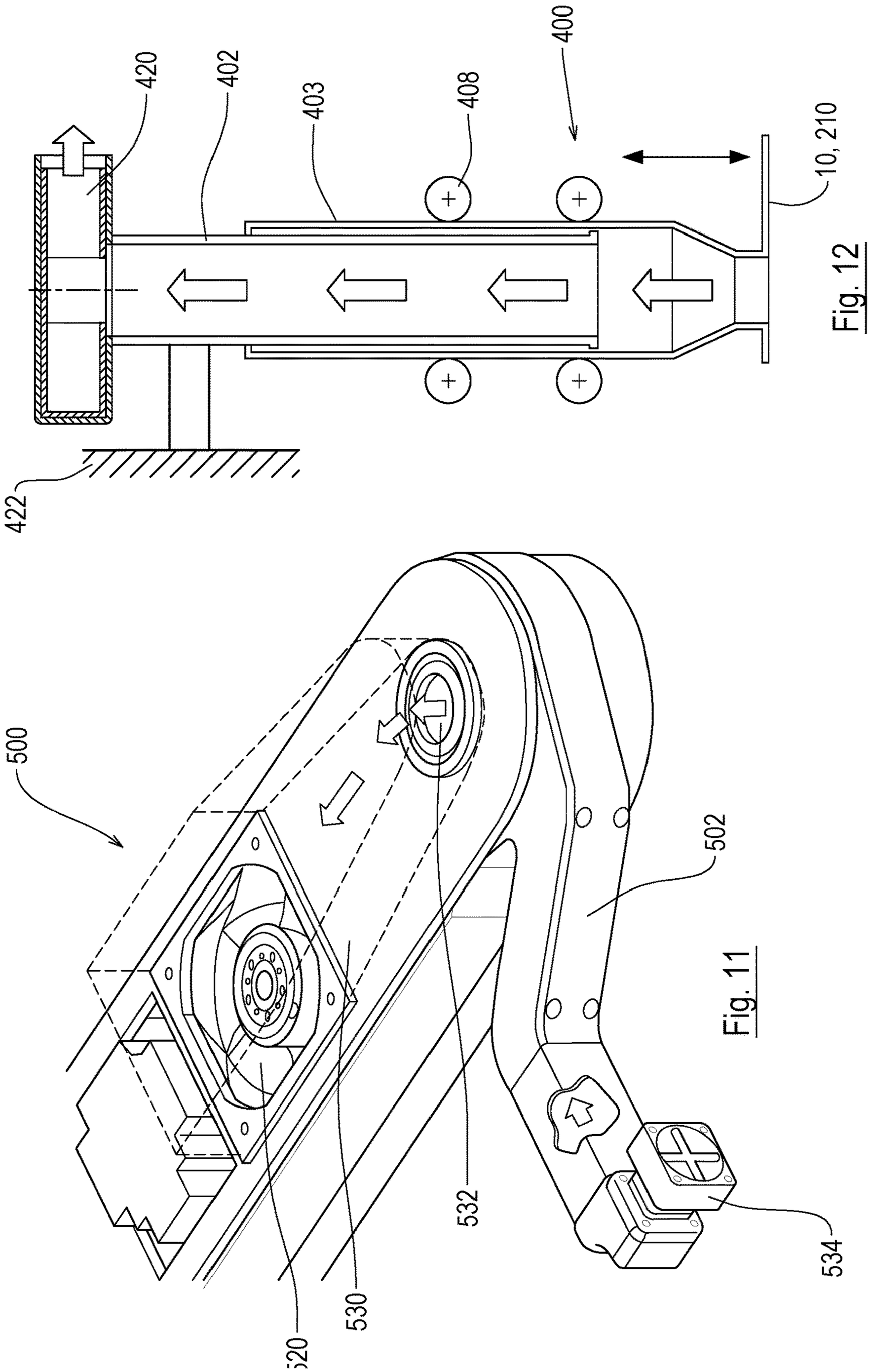

Fig. 12

Fig. 11

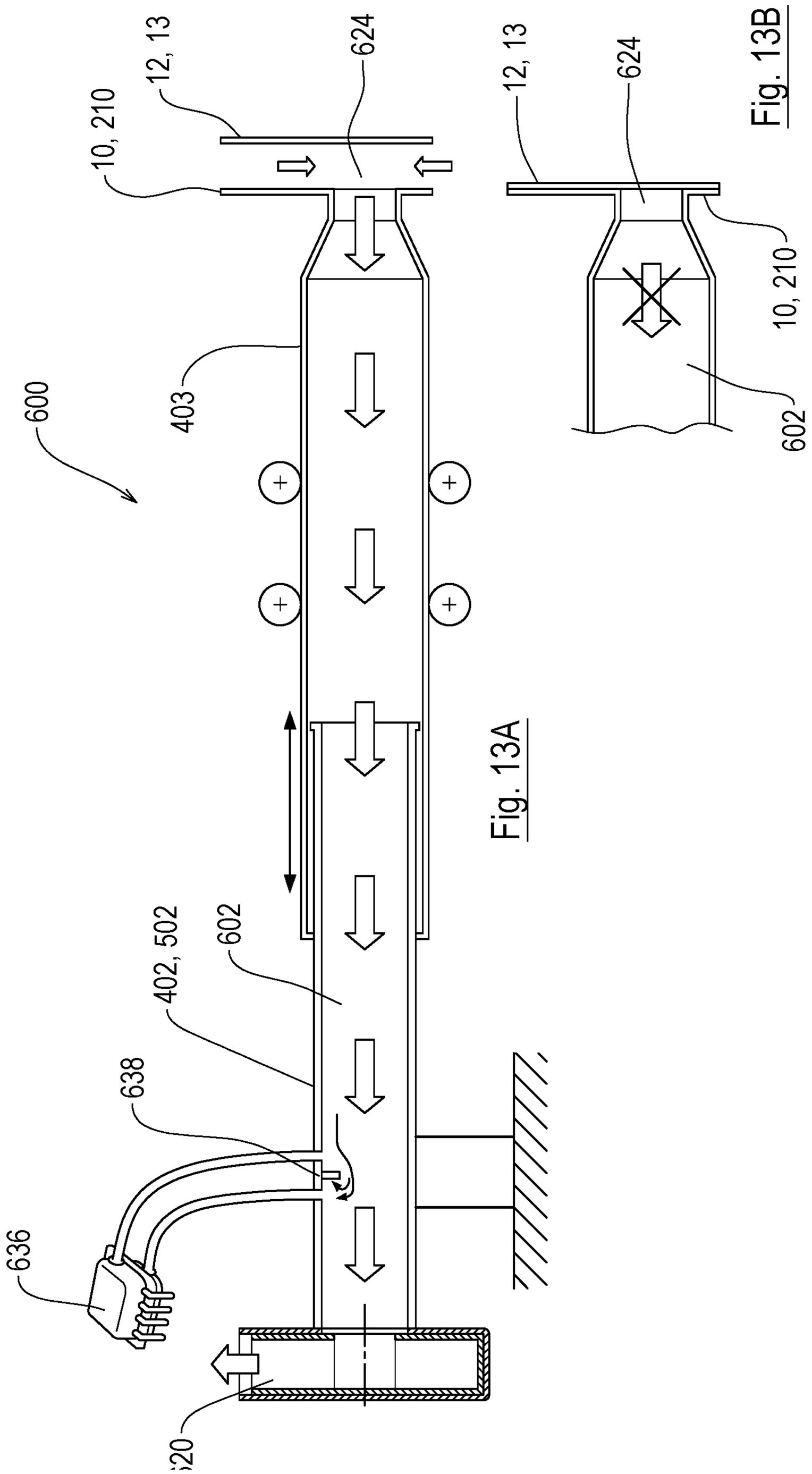

Fig. 13A

Fig. 13B

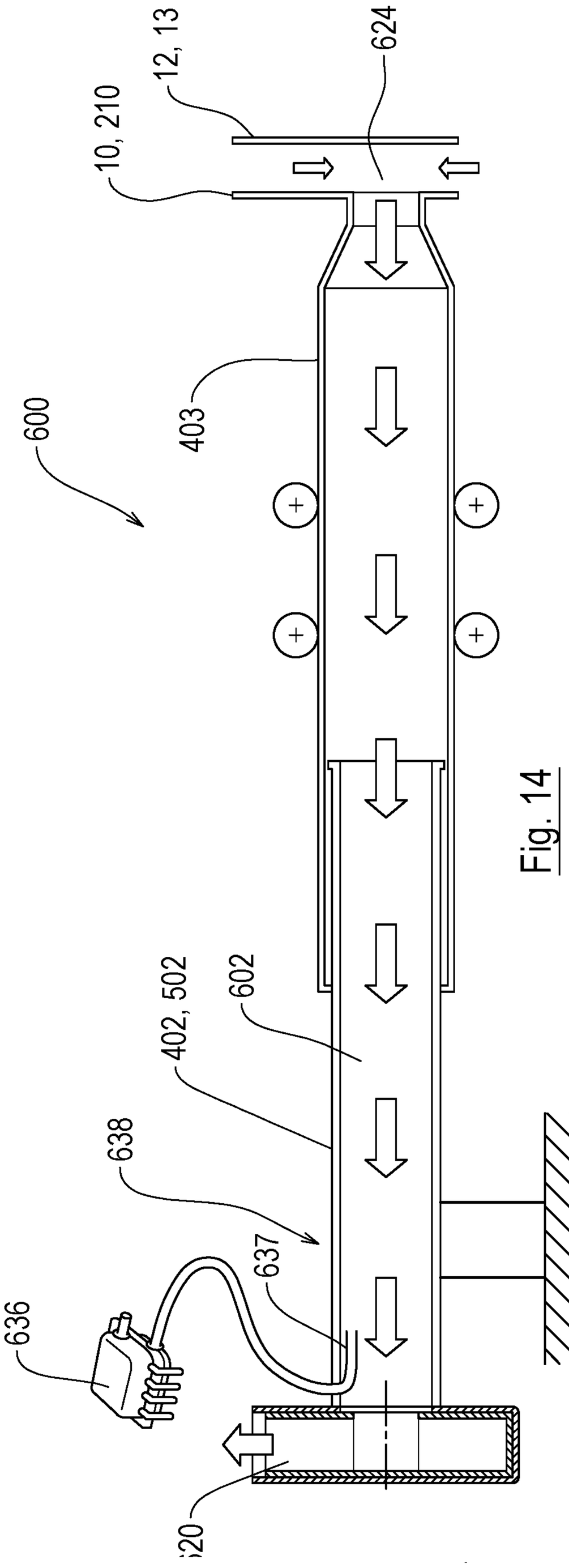

Fig. 14

APPLICATOR APPARATUS AND METHOD

DESCRIPTION OF INVENTION

Embodiments of the invention relate to an applicator apparatus and parts thereof and associated methods, in particular but not exclusively to a labelling apparatus and methods for use with a print and apply printing apparatus.

It is known in the art of printing, in particular label printing, for labels to be attached to a carrier web, which passes a printhead of a printing apparatus to be printed, before the labels are removed from the carrier web and applied to an item, for example a package. Each label is typically manufactured from paper and has a printing side, which passes adjacent the printhead for ink to be applied to it, for example to provide information, barcodes, images, etc., and an attachment side, which typically bears a layer of adhesive which initially adheres the label to the carrier web, and then subsequently to the item to which the label is applied. It is also known for labels to be manufactured from thin plastics materials. Other materials may be used. The carrier web may have a waxy texture or coating, so as to enable the separation of the labels from the carrier web. It is known in the art to provide an applicator pad or "tamp pad" to apply each printed label to a respective item. Each label is fed away from the printhead, towards the applicator pad, and the printing side of the label as held adjacent the applicator pad, typically by a vacuum. The applicator pad may then move relative to the printhead, towards a surface of the item to which the label is to be applied, and place the attachment side of the label against the surface, such that the adhesive adheres the label to the surface of the item. The air pressure in the region of the applicator pad and the label may then be increased, so as to reduce the suction between the applicator pad and the label, such that the label detaches from the applicator pad and remains adhered to the surface of the item. Movement of the applicator pad is typically effected by an actuator, and the applicator pad is typically secured to the actuator by screws or similar mechanical fixings, meaning that one or more tools is required to remove the applicator pad for maintenance or replacement. Pneumatic pipes and electronic connections typically have to be connected between the actuator and the applicator pad. Therefore, replacement and maintenance of an applicator pad is time consuming, and there is significant opportunity for human error to occur. This can cause production delays and damage to apparatus.

Known applicator pads are designed to handle a range of label sizes, typically from 26 mm×26 mm to 170 mm×226 mm. Industry convention has been to utilise plastic pneumatic pipes to transfer air at high pressure, e.g. 1-10 bar, (100,000 Pa-1,000,000 Pa) to create the vacuum required to hold a label adjacent the applicator pad and increase the air pressure during application. The high pressure air is then typically used to create the vacuum at the pad itself meaning additional weight and complexity on the moving pad.

It is known to use an array of jets which are separate from the applicator pad to direct each label as it moves away from the printhead, so as to move each label into a region influenced by the vacuum which is generated by the applicator pad.

It is also known to provide actuators for moving an applicator pad to apply labels to a target surface. Known actuators include heavy/and or bulky moving parts. Actuators are typically pneumatically or electrically activated.

In accordance with embodiments of the invention, there is provided an applicator apparatus including an applicator pad and an actuator for positioning the applicator pad in a desired position, the applicator pad being attached to the actuator by an attachment member, wherein the attachment member enables articulation between the applicator pad and the actuator.

Part of the attachment member may be arranged to slidably engage with a part of the applicator pad.

The attachment member may include an engagement member which is arranged to engage with an engagement formation of the applicator pad in a dovetail arrangement.

The attachment member and the applicator pad may be configured to snap-fit with one another.

The applicator apparatus may include a locking formation for locking the applicator pad in attachment with the actuator.

The attachment member may include a universal joint.

The attachment member may enable pneumatic coupling between the applicator pad and the actuator.

The applicator apparatus may include an air flow generator.

The air flow generator may be carried by a part of the actuator.

The air flow generator may be located on a stationary part of the applicator apparatus.

The air flow generator may be operable to produce an air flow with an air pressure of up to approximately 1000 Pa.

The applicator pad may have a first, label receiving side and a second side, a label entrance edge and an opposite edge, a fluid inlet and a fluid conduit arrangement which may be fluidly communicable with the fluid inlet to deliver fluid from the fluid inlet to a plurality of positions on the first label receiving side.

The fluid inlet of the applicator pad may be fluidly communicable with the air flow generator via the attachment member.

The fluid inlet may be positioned near to the label entrance edge of the applicator pad and at least a part of the conduit arrangement may extend away from the label entrance edge of the applicator pad towards the opposite edge of the applicator pad.

The fluid conduit arrangement may include a plurality of conduits.

Two or more of the plurality of conduits may include respective portions which are substantially parallel with one another.

The cross-sectional area of the fluid inlet may be approximately 25% to 75% of the area of the applicator pad, and preferably may be approximately 50% of the area of the applicator pad.

The label receiving side of the applicator pad may include a portion having a roughened surface, and the portion may cover at least a part of the first, label receiving side of the applicator pad. The portion may cover multiple parts of the first, label receiving side of the applicator pad. The portion may cover the entire first, label receiving side of the applicator pad.

The roughened surface may be provided by an additive manufacturing process and/or a moulding process.

The applicator pad may include one or more stiffening ribs.

The applicator pad may include one or more nozzles terminating at or near the label receiving side of the applicator pad, the or each nozzle being fluidly communicable with a pressurised fluid source.

The pressurised fluid source may be the air flow generator.

The applicator apparatus may include a plurality of nozzles, at least some of which may be fluidly communicable with the source of pressurised fluid via a distribution chamber.

The applicator apparatus may include at least one opening in the label side of the applicator pad, the or each opening being associated with a corresponding nozzle.

Each opening may surround the corresponding nozzle.

There is also provided an applicator apparatus including an applicator pad for applying a label to an item, an air flow generator, an air guide for guiding the air flow between the air flow generator and the applicator pad, and a label detector for detecting the presence of a label adjacent the applicator pad, wherein the label detector includes a flow sensor for measuring air flow at a location between the air flow generator and the applicator pad.

The flow sensor may be a differential pressure sensor.

The air guide may include an obstacle, and the differential pressure sensor may measure air pressure on both sides of the obstacle.

The applicator apparatus may include any or all of the features set out above, in any combination.

There is also provided an actuator for an applicator apparatus, the actuator being operable to position an applicator pad in a desired position relative to an item to which a label is to be applied, the actuator including one of an extruded or pultruded body to which the applicator pad is connectable.

The actuator may include at least two telescopic bodies.

The actuator body may enable fluid communication between the applicator pad and a source of pressurised fluid and/or an air flow generator.

The actuator may include at least one bearing member which is engageable with a part of a label printing apparatus to facilitate movement of at least a part of the actuator relative to the part of the label printing apparatus.

The or each bearing member may be a roller.

The actuator may be used in combination with any or all of the features of the applicator apparatus set out above.

There is also provided a method of controlling an applicator apparatus including an applicator pad for applying a label to an item, an actuator for positioning the applicator pad in a desired position relative to an item, and a control system for controlling movement of the actuator, the control system including at least one motor, the method including determining a desired position of the applicator pad, determining a required speed of the actuator to achieve the desired position of the applicator pad, taking into account at least one physical parameter of the actuator and/or the applicator pad, and calculating a motor torque required to achieve the desired position of the applicator pad, taking into account a current position of the applicator pad.

The method may include determining an impact of the applicator pad with the item by detecting one or more of an increase in motor current, a change in speed of movement of the actuator and an increase in a difference value between the desired position of the applicator pad and an actual position of the applicator pad.

The method may include determining an impact zone, and the control system may operate under different conditions when the actual position of the applicator pad is determined to be within the impact zone.

The method may be for applying a label to each of a series of items, wherein the control system may be operable to determine a respective impact zone associated with each item to which a label is to be applied.

The method may include reducing control stiffness, and/or operating the motor in an open-loop torque mode and/or utilising a model-based feed-forward algorithm to control the motor when the applicator pad is determined to be in the impact zone.

The method may include adjusting the control parameters of the control system in response to detecting a collision between the applicator pad and the item.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, of which:

FIG. **1** is an illustrative perspective view showing a first side of an applicator pad receiving a part of a label;

FIG. **2** is an illustrative perspective view showing a second side of the applicator pad of FIG. **1**;

FIG. **3** is an illustrative perspective view of an applicator pad and an associated attachment device for attaching the applicator pad to an actuator;

FIG. **4**A is an alternative illustrative perspective view of an applicator pad and an associated attachment device for attaching applicator pad to an actuator;

FIG. **4**B is a cross-sectional view of part of an attachment device for attaching an applicator pad to an actuator;

FIG. **5**A is an illustrative perspective view of an embodiment of an applicator pad;

FIG. **5**B is an illustrative perspective view of the embodiment of an applicator pad of FIG. **5**A, showing a label receiving side of the applicator pad;

FIG. **6** is a process diagram, illustrating a control system for a part of a labelling apparatus;

FIG. **7** is a velocity profile and an associated position profile of an actuator and applicator pad of a labelling system;

FIG. **8** is an illustrative perspective view of a part of an actuator;

FIG. **9** is a cross-sectional view of the part of the actuator of FIG. **8**;

FIG. **10** is an illustrative cross-sectional view showing the actuator of FIGS. **8** and **9** attached to a part of a printing apparatus;

FIG. **11** is an illustrative perspective view of a part of an alternative actuator;

FIG. **12** is an illustrative cross-sectional view of an actuator;

FIG. **13**A is an illustrative cross-sectional view of a label detection apparatus, with no label adjacent the applicator pad;

FIG. **13**B is an illustrative cross-sectional view showing part of the label detection apparatus, with a label adjacent the applicator pad; and

FIG. **14** is an illustrative cross-sectional view showing part of an alternative embodiment of the label detection apparatus.

Referring to FIGS. **1** and **2**, there is shown an applicator pad **10** for a labelling apparatus, receiving a label **12**. The applicator pad **10** has a first side or label receiving side **14** and a second side **16**. The applicator pad **10** also has a label entrance edge **18**, and an opposite edge **19**. The label **12** has a leading edge **12***a* and a trailing edge **12***b*.

The applicator pad **10** includes a conduit arrangement **20**, which in embodiments includes a plurality of conduits **22** which are fluidly communicable with one another. The conduit arrangement **20** is also fluidly communicable with an inlet **24**, which may be an air inlet. In embodiments, the inlet **24** may be fluidly communicable with each of the conduits **22**. The inlet **24** is positioned adjacent the label entrance edge **18**. For example an edge of the inlet **24** may

be located approximately 2-15 mm (preferably approximately 12 mm) from the label entrance edge **18** of the pad **10**. The inlet **24** and at least a part of the conduit arrangement **20** may be fluidly communicable with the label receiving side **14** of the applicator pad **10**. Fluid, for example air, may be drawn into the applicator pad **10** via at least a part of the inlet **24** and/or at least a part of the conduit arrangement **20**. The inlet **24** may have a large cross-sectional area in the plane of the label receiving side **14**.

The cross-sectional area of the inlet **24** in a plane substantially parallel to or co-incident with the label receiving side **14** may be dependent upon the size of the applicator pad **10**. The inlet **24** may be substantially circular in cross section, or it may be substantially rectangular in cross section, for examples. The cross-sectional area of the inlet **24** in a plane substantially parallel to or co-incident with the plane of the label receiving side **14** may be approximately 240 mm^2 for labels larger than 40 mm wide and 30 mm long. The minimum cross sectional area of the inlet **24** in the plane of the label receiving side **14** is 140 mm^2. Smaller cross sectional areas of the inlet **24** may deteriorate the air flow thus affecting the label attraction properties. For smaller labels (i.e. labels having dimensions less than 40 mm×30 mm) the cross-sectional area of the inlet **24** may be smaller. The cross-sectional area may be 48 mm^2. Ideally the inlet **24** should cover approximately 50% of the small label pad **10**.

The cross sectional area of each of the conduits **22** may be small relative to the cross-sectional area of the inlet **24**, and each conduit **22** may be between approximately 1 mm and approximately 5 mm wide, and may be approximately 2 mm wide, for example.

The applicator pad **10** may include one or more guard ribs **28** which extend across at least a part of the inlet **24**. The or each guard rib **28** may extend in a plane which is substantially perpendicular to the plane of the applicator pad and hence substantially perpendicular to the cross-section of the inlet **24**. The or each guard rib **28** may inhibit labels and/or foreign objects entering (for example being sucked into) the inlet **24**. The number of guard ribs **28** may be governed by the thickness of the labels being used and the air pressure.

In embodiments, the conduit arrangement **20** may include four conduits **22**, for example (as shown in FIG. **1**). More or fewer than four conduits **22** may be provided. The or each conduit **22** may include a substantially straight portion. A part of one or more of the conduits **22** may extend away from the label entrance edge **18** of the applicator pad **10**, towards the opposite edge **19**. The substantially straight portion of the or each conduit **22** may extend away from the label entrance edge **18** of the applicator pad **10**, towards the opposite edge **19**. Where the conduit arrangement **20** includes a plurality of conduits **22**, corresponding portions of two or more of the plurality of conduits **22** may be parallel with one another.

The purpose of the conduit arrangement **20** and the inlet **24** is to provide a suction or vacuum effect, which is capable of holding the label **12** adjacent the label receiving side **14** of the applicator pad **10**, against gravity, for example. An air flow generator, for example a fan, is provided, and is fluidly communicable with the inlet **24**. The conduit arrangement **20** and/or the inlet **24** enables labels **12** to be attracted towards the applicator pad **10** without the need for additional directional air jets, for example external air jets, or other form of directing apparatus which are required to guide the labels towards the applicator pads of known label applicator systems.

The label receiving side **14** of the applicator pad may include a portion having a structure, which may be a roughened surface, which has the effect of reducing the contact surface area between the label receiving side **14** and the label **12**. The portion **26** having the roughened surface may extend over the entire surface are of the label receiving side **14**. The portion **26** having the roughened surface may extend over a part or parts of the surface of the label receiving side **14**. The portion **26** having the roughened surface may include a number of discrete portions. This provides a low adherence or "non-stick" effect which is advantageous in a situation where the adhesive side of a label **12** comes into contact with the applicator pad. Such an inadvertently adhered label **12** may be easily removed manually, or may even fall off of its own accord as a result of the roughened surface.

The structure of the portion **26** of the label receiving side **14** may be provided in or on the label receiving side **14** of the applicator pad **10** as the applicator pad **10** is manufactured. The applicator pad **10** may be moulded, for example injection moulded. The applicator pad **10** may be produced by additive manufacturing, e.g. 3D printing or Selective Laser Sintering (SLS). If the applicator pad **10** is produced by additive manufacturing (which is a powder-based manufacturing process), an outer surface (which includes the label receiving side) may be naturally rough, providing the structure or roughened surface which provides the low adherence property of the label receiving side **14** of the applicator pad **10**. If the applicator pad **10** is produced by a moulding process, the structure providing the low adherence property of the label receiving side **14** may be moulded into the portion **26** of the label receiving side **14**.

The second side **16** of the applicator pad **10** may include one or more stiffening ribs **30**. The ribs **30** may be provided in a grid arrangement, for example, or another advantageous arrangement, for example a honeycomb, or triangular arrangement. The arrangement of the ribs **30** may be selected to provide optimum torsional stiffness. The cross-sectional shape of the or each rib **30** (i.e. in a plane substantially perpendicular to the plane of the second side **16** of the applicator pad **10**) may be uniform, or may vary with the height of the rib **30**. For example, the or each rib **30** may be T-shaped. The cross-sectional shape of the or each rib **30** may be dependent upon the manufacturing process.

A desirable ratio of stiffness to weight of the applicator pad **10** may determine the cross-sectional shape and/or height of the or each rib **30**, and/or the number of ribs **30** provided and/or the arrangement of the ribs **30**. The thickness of the applicator pad **10** (not including ribs **30**) may be between approximately 0.5 mm and approximately 1 mm. Each rib **30** may have a width of between approximately 1 mm and 1.5 mm and a height (perpendicular to the pad **10**) of between approximately 3 mm and 15 mm, and may be approximately 6 mm, for example.

In order to facilitate the manufacture of embodiments of the applicator pad **10**, a parametric computer aided design (CAD) model may be provided to create instructions for an additive manufacturing method. Entering the desired applicator pad width W and length L into the model will generate instructions to produce all of the features of the applicator pad **10**. It may be possible for a designer to select whether to include optional features.

In use, a label **12** is transported away from a printhead of a printing apparatus, typically by motor-driven spools which wind a carrier web **15** bearing a series of labels **12**, **13** in the required direction, and each label **12**, **13** is separated from the carrier web **15**, for example by a peel-off roller or blade. The label **12** is travelling in the direction shown by the arrow marked A in FIG. **1**. As the label **12** is removed from the

carrier web **15**, the label **12** travels towards the label entrance edge **18** of the applicator pad **10**. The leading edge **12***a* of the label **12** is separated from the carrier web **15** before the trailing edge **12***b*, and the leading edge **12***a* of the label **12** engages with the label receiving side **14** of the applicator pad **10** before the trailing edge **12***b* of the label **12** has been separated from the carrier web **15**.

As the label **12** moves across the label receiving side **14** of the applicator pad **10** in the direction of arrow A, at least a part of the label **12** covers an increasing proportion of the inlet **24** of the applicator pad **10**. As the inlet **24** is covered, air is then sucked through at least a part of the conduit arrangement **20**. As the label **12** continues to travel in the direction of arrow A, the conduit arrangement **20** is progressively covered, and air is then sucked through an uncovered part or parts of the conduit arrangement **20**. This arrangement means that as the label **12** moves across the applicator pad **10**, the effective air inlet (i.e. the part or parts of the air inlet **24** and/or the conduit arrangement **20** which is/are uncovered at a given moment) moves further away from the label entrance edge **18** of the applicator pad **10**. This enables the transfer of labels having a range of sizes by the same applicator pad **10**. The largest label **12** which can be handled by the applicator pad is determined by the physical size of the applicator pad **10**, and the smallest label size is defined by a rectangular area defined by the outermost conduits **22** and may be approximately two thirds of the length (measured from the label entrance edge **18** towards the opposite edge **19**) and two thirds of the width W (symmetric about a centreline of the applicator pad **10**) of the label receiving side **14** of the applicator pad **10**. The width of the conduits **22** is selected to ensure that even the thinnest labels do not become distorted or buckled in the vicinity of the conduits **22**. The width of each conduit may be selected such that a resulting total vacuum area at a position behind the inlet **24** (i.e. between the inlet **24** and the air flow generator, rather than on the label receiving side **14** of the applicator pad **10**) is no more than twice the cross-sectional area of the inlet **24** plus the cross-sectional area of portions of the conduits **22** positioned between the inlet **24** and the opposite edge **19** of the label pad **10**.

Alternative arrangements of the applicator pad **10** and the conduit arrangement **20** may be selected, and the optimum arrangement may be selected based upon the size of the labels intended to be printed by the printing apparatus with which the applicator pad **10** is intended to be used.

Advantages of embodiments of the applicator pad **10** described herein are that the roughened portion **26** of the label receiving side **14** may eliminate the need to coat the label receiving side **14** (or a portion or portions of the label receiving side **14**) with a "non-stick" coating. This removes a manufacturing step. The applicator pad **10** is particularly optimised for high volume, low air pressure air flows as produced by a localised air flow generator (e.g. fan) system, in contrast to the low volume, high pressure air flows produced by an external pneumatic generator, i.e. factory generated air.

Referring to FIG. **3**, in particular, the applicator pad **10** forms part of an applicator apparatus, and is attached to an actuator, which effects movement of the applicator pad **10**, by an attachment member **40**. The attachment member **40** may provide at least one of mechanical coupling and pneumatic coupling between the applicator pad **10** and the actuator. The attachment member **40** includes a body **42**. In embodiments a cross-section of part of an outer surface the body **42** may be substantially square. The body **42** includes an opening **44**. The opening **44** may extend all the way through the body **42**. The attachment member **40** may include an engagement member **46**. In embodiments the engagement member **46** may include a pair of protrusions **46***a*, **46***b*. Each protrusion **46***a*, **46***b* may be substantially triangular in cross section, but it will be appreciated that other forms may be possible or desirable. For example, the or each protrusion may be substantially flat, square, rectangular or rounded in cross section. In embodiments, the or each engagement member **46** may extend laterally outwardly from the body **44**, at or near to a base **48** of the attachment member **40**. The attachment member **40** may also include a locking formation **50**. In embodiments, the locking formation **50** may be an opening or slot. The locking formation may be provided in the base **48** of the attachment member **40**. The locking formation **50** may be provided substantially centrally of the attachment member **40**, and may extend in a direction which is substantially parallel with the or each engagement member **46**.

The applicator pad **10** may include an engagement formation **36** which is engageable with the engagement member **46** of the attachment member **40**. In embodiments, the engagement formation **36** may include one or more lips **36***a*, **36***b*, which extends from the second side **16** of the applicator pad. The or each lip **36***a*, **36***b* may provide a channel in which a corresponding one of the or each protrusion **46***a*, **46***b* of the engagement member **46** is receivable. The or each lip **36***a*, **36***b* may be angled or curved to provide the respective channel of the engagement formation **36**.

The engagement member **46** and the engagement formation **36** may be configured to enable sliding engagement of the attachment member **40** to the applicator pad **10**. The engagement member **46** and the engagement formation **36** may enable the attachment member **40** to attach to the actuator in a 'dovetail' arrangement. The attachment member **40** may enable a 'snap fit' engagement between the applicator pad **10** and the actuator.

The engagement formation **36** may be located near or adjacent the label entrance edge **18** of the applicator pad **10**. The engagement formation **36** may be located near or adjacent the inlet **24**. A part or parts of the engagement formation **36** may partially or substantially surround the inlet **24**.

The applicator pad **10** may include a locking member **52** which is engageable with the locking formation **50** of the attachment member **40**. In embodiments, the locking member **52** may include a tongue, which is receivable in the locking formation **50** of the attachment member **40**. The locking member **52** may extend across at least a part of the inlet **24**, in a direction which is substantially parallel with the or each lip **36***a*, **36***b* of the engagement formation **36**. The locking member **52** may include a detent or lip **54** which is engageable with a part of the attachment member **40**, to inhibit accidental removal of the applicator pad **10** from the attachment member **40**. The locking member **52** may be flexible to enable the locking member **52** to be disengaged from the attachment member, for example to enable removal, replacement and/or maintenance of the applicator pad **10**.

The attachment member **40** may be flexible or at least a part of the attachment member **40** may be flexible and/or articulated, to enable the position and/or orientation of the applicator pad **10** relative to the actuator to be adjusted, to enable the applicator pad **10** to conform to a surface to which the label **12** is to be applied. It is possible for this adjustment to be made passively, in the event that the applicator pad **10** contacts the surface to which the label **12** is to be applied, or actively, if the labelling apparatus determines that the

position or orientation of the surface to which the label **12** is to be applied is different from the current position or orientation of the applicator pad **10**. The adjustment of the position and/or orientation of the applicator pad **10** may be made by a combination of active and passive adjustment.

The configuration of the attachment member **40** is such that the adjustment of the position and/or orientation of the applicator pad **10** may be made whilst maintaining the integrity of the airways which flow through the attachment member **40**. The configuration of the attachment member **40** may inhibit or prevent rotation of the applicator pad **10** relative to the actuator to avoid misplaced (for example skewed) labels **12**.

The engagement formation **36** and the locking member **52** (where provided) may be positioned adjacent and/or substantially aligned with the inlet **24** of the applicator pad **10**.

The attachment member **40** may be permanently or semi-permanently fixed to the actuator, for example with screws or similar fixings, or may be integral with the actuator.

FIGS. **4**A and **4**B show an embodiment of an attachment member **140**. Features of the attachment member **140** which are similar to those of the attachment member **40** are denoted with similar reference numerals, with a '1' prefix. The attachment member **140** includes a first part **142** and a second part **143**. The attachment member **140** has a substantially longitudinal axis A. The attachment member **140** includes a connecting member **145** which connects the first part **142** to the second part **143** of the attachment member **140**.

The first part **142** is a body which includes a base **148**, and an engagement member **146**. The engagement member **146** may include a pair of protrusions **146***a*, **146***b* which are receivable in the engagement formation **36** of the applicator pad **10**. The first part **142** includes an opening **144** through which pneumatic connections may pass. Electronic connections may also pass through the first part, although this is not essential. The first part may include a holding member **141** for holding a part of the connecting member **145**. The holding member **141** may be a seat for a part of the connecting member **145**. The holding member **141** may include an opening through which a part of the connecting member **145** may pass. An outer surface of the first part **142** may be shaped to be receivable in and moveable relative to the second part **143**. A part of the outer surface of the first part **142** may be curved. The external shapes of the first part **142** and the second part **143** may be selected to co-operate with one another. The engagement of the first part **142** and the second part **143** provides a sealing engagement, such that the first part **142** and the second part **143** are fluidly communicable with one another. A pneumatic connection may be maintained by the connection between the first part **142** and the second part **143**.

A realignment member **155** may be connected between the second part **143** and the connecting member **145**. The realignment member **155** may be a resilient member **155**, for example a spring. The realignment member **155** is provided to return the first part **142** and **143** to substantially co-axial alignment in the event of the first part **142** and the second part **143** tilting relative to one another. Where the realignment member **155** is a spring, a spring force may be transmitted through the connecting member **145** to the holding member **142**, such that the holding member **141** is maintained in contact with the second part **143** of the attachment member **140**. The realignment member **155** exerts the spring force on the holding member **141** in a direction towards the second part **143**, in a direction which is substantially normal to the plane of the attachment pad **10**, so as to exert a realignment force on the holding member **141**, to bring the holding member **141** and the second part **143** of the attachment member into substantially co-axial alignment with one another.

The second part **143** includes a first opening **147**. The first opening may extend substantially centrally through the second part **143**. The first opening **147** may receive a part of the connecting member **145**. The second part **143** includes a second opening **149** in which at least a proportion of the first part **142** of the attachment member **140** is receivable. The second opening **149** may be substantially annular, and may be substantially concentric with the first opening **147**, about the axis A. The second opening **149** may be located axially outwardly of the second part **143**, relative to the axis A. The second part **143** is configured to be attached to an actuator **180**. The second part **143** may include a portion which is manufactured from a resilient material. The second opening **149** may be defined by the portion which is manufactured from a resilient material, to enable the second part to accommodate movement of the first part **142** within the second opening **149**.

The connecting member **145** may include a ball element **145***a* and a shaft **145***b*. The shaft **145***b* may extend through the first opening **147** of the second part **143**, and through the opening in the holding member **141** of the first part **142**.

The first part **142** and the second part **143** of the attachment member **140** may articulate with one another. The attachment member **140** may form a universal joint. The attachment member **140** may enable pivotal and/or rotational movement of the applicator pad **10** relative to the actuator **180**.

Different sizes and shapes of the attachment member **40**, **140** are possible, for use with different sizes of applicator pad and/or actuator.

An embodiment of an applicator pad **210** is shown in FIGS. **5**A and **5**B. FIG. **5**B shows a first, label receiving side **214** of the applicator pad **200**, and FIG. **5**A shows a second side **216** of the pad **200**. Embodiments of an applicator pad such as the embodiment shown in FIGS. **5**A and **5**B may be advantageous in circumstances when an impact between the applicator pad **210** and the surface to which the label is to be applied is undesirable, or is not possible, for example if the surface to which the label is to be applied is delicate, or an item beneath the surface to which the label is to be applied is delicate and/or fragile and/or the surface to which the label is to be applied may be uneven. In such situations, it is desirable to apply the label by blowing the label on to the surface to which it is to be applied. It is known to combine a blowing process and a tamping (pressing) process to apply labels.

Referring to FIGS. **5**A and **5**B, there is shown an applicator pad **210** for a labelling apparatus. The applicator pad **210** has a first side or label receiving side **214** and a second side **216**. The applicator pad **210** also has a label entrance edge **218**, and an opposite edge **219**.

The applicator pad **210** includes a conduit arrangement **220**, which in embodiments includes a plurality of conduits **222** one or more of which may be fluidly communicable with one another. The conduit arrangement **220** may also be fluidly communicable with an inlet **224**, which may be an air inlet. In embodiments, the inlet **224** may be fluidly communicable with each of the conduits **222**. The inlet **224** may be positioned adjacent the label entrance edge **218**. For example an edge of the inlet **224** may be located approximately 2-15 mm (preferably approximately 12 mm) from the label entrance edge **218** of the pad **214**. The inlet **224** and at least a part of the conduit arrangement **220** may be fluidly

communicable with the label receiving side **214** of the applicator pad **210**. Fluid, for example air, may be drawn into the applicator pad **210** via at least a part of the inlet **224** and/or at least a part of the conduit arrangement **220**. The inlet **224** may have a large cross-sectional area in the plane of the label receiving side **214**.

The cross-sectional area of the inlet **224** in a plane substantially parallel to or co-incident with the label receiving side **214** may be dependent upon the size of the applicator pad **210**. The inlet **224** may be substantially circular in cross section, or it may be substantially rectangular in cross section, for examples. The cross-sectional area of the inlet **224** in a plane substantially parallel to or co-incident with the plane of the label receiving side **214** may be approximately 240 mm^2 for labels larger than 40 mm wide and 30 mm long. The minimum cross sectional area of the inlet **224** in the plane of the label receiving side **214** is 140 mm^2. Smaller cross sectional areas of the inlet **224** may deteriorate the air flow thus affecting the label attraction properties. For smaller labels (i.e. labels having dimensions less than 40 mm×30 mm) the cross-sectional area of the inlet **224** may be smaller. The cross-sectional area may be 48 mm^2. Ideally the inlet **224** should cover approximately 50% of the small label pad **214**.

The purpose of the conduit arrangement **220** and the inlet **224** is to provide a suction or vacuum effect, which is capable of holding the label **12** adjacent the label receiving side **214** of the applicator pad **210**, against gravity, for example.

The cross sectional area of each of the conduits **222** may be small relative to the cross-sectional area of the inlet **224**, and each conduit **222** may be between approximately 1 mm and approximately 5 mm wide, and may be approximately 2 mm wide, for example. The width of the conduits **222** is selected to ensure that even the thinnest labels do not become distorted in the vicinity of the conduits **222**.

The cross-sectional area of the inlet **224** in the plane of the label receiving side **214** may be dependent upon the size of the applicator pad **210**. The cross-sectional area of the inlet **224** may be greater than or equal to 135 mm^2 for 'standard' sized applicator pads, but may have a smaller cross-sectional area for applicator pads **210** which are produced for the application of small labels. The applicator pad **210** may include one or more guard ribs **228** which extend across at least a part of the inlet **224**. The or each guard rib **228** may extend in a plane which is substantially perpendicular to the plane of the applicator pad **210** and hence substantially perpendicular to the cross-section of the inlet **224**. The or each guard rib **228** may inhibit labels and/or foreign objects entering (for example being sucked into) the inlet **224**.

In embodiments, the conduit arrangement **220** may include four conduits **222**, for example (as shown in FIG. **5**B). More or fewer than four conduits **222** may be provided. The or each conduit **222** may include a substantially straight portion. A part of one or more of the conduits **222** may extend away from the label entrance edge **218** of the applicator pad **210**, towards the opposite edge **219**. The substantially straight portion of the or each conduit **222** may extend away from the label entrance edge **218** of the applicator pad **210**, towards the opposite edge **219**. Where the conduit arrangement **220** includes a plurality of conduits **222**, corresponding portions of two or more of the plurality of conduits **222** may be parallel with one another.

The applicator pad **210** includes an opening or port **202**. The port **202** may be near to or adjacent the inlet **224**. Fluid, for example air, may be supplied to the applicator pad **210** through the port **202**, for example from an external fluid source, for example an air compressor.

The applicator pad **210** may include a distribution arrangement **204**. The distribution arrangement **204** may include a distribution chamber **206** which may be fluidly communicable with the port **202**. The distribution arrangement **202** may include one or more distribution conduits **208**, each of which may be fluidly communicable with the distribution chamber **206** and/or the port **202**. The applicator pad **210** may include a nozzle **209** or a plurality of nozzles **209**, each of which may be associated with a respective distribution conduit **208**. The or each distribution conduit **208** may terminate in a respective nozzle **209**. The or each distribution conduit **208** may include one or more curved portions. The or each curved portion may have as large a bend radius as space will allow, to optimise fluid flow through the or each distribution conduit **208**.

The or each nozzle **209** includes a small aperture, which acts as a fluid outlet. The or each nozzle **209** may have the smallest cross-sectional area, of the distribution arrangement **204**. The total cross-sectional area of the nozzles **209** may be smaller than any of a fluid delivery path which extends between the fluid source and the nozzle, via the port **202**, the distribution chamber **204** and the or each distribution conduit **208**. The total cross-sectional area of the nozzles **209** may be smaller than the smallest cross-sectional area of any other part of an air flow path, between the fluid source and the nozzles **209**. Providing the smallest cross sectional area at the or each nozzle provides high speed fluid flow at the or each nozzle **209**, which may optimise thrust, to move the label **12** away from the label receiving side **214** of the applicator pad **210**. The speed of the fluid leaving the or each nozzle **209** may be ultrasonic.

The applicator pad **210** includes one or more openings **207**, each of which is associated with a respective nozzle **209**. The or each opening **207** may surround the respective nozzle **209**. The or each nozzle **209** may be substantially centred in the respective opening **207**. The or each opening **207** may have a large cross-sectional area relative to the respective nozzle **209**. The diameter of the or each opening **207** may be approximately 11 mm. The or each opening **207** may enable air, for example ambient air, to be drawn into the applicator pad **210**. Air may be drawn through the applicator pad **210** via the or each opening **207**. This inhibits labels **12**, **13** from sticking to the pad during application to a surface, and improves the efficiency of the 'blow' process. The openings **207** inhibit the formation of a vacuum between the label **12**, **13** and the applicator pad **210**, which is important during a blow process, but which is not relevant when tamping a label on to the surface to which the label is to be applied. The cross-sectional area of the or each opening **207** may be optimised to ensure that the air flow effect is sufficient, but that there is sufficient material of the applicator pad **210** remaining to provide space and/or support for the or each distribution conduit **208** and/or the distribution chamber **204**.

The conduit arrangement **220** and/or the inlet **224** enables labels **12**, **13** to be attracted towards the applicator pad **210** without the need for additional directional air jets, for example external air jets, or other form of directing apparatus which are required to guide the labels towards the applicator pads of known label applicator systems.

The applicator pad **210** may include an engagement formation which is engageable with an attachment member which may be similar to or the same as the attachment member **40** as described above. The applicator pad **210** may

be attachable to an actuator which may be the same as or similar to the actuator **180** described above and/or as shown in the drawings.

The configuration of the applicator pad **210** is complex, and may not be achieved with known moulding processes. Therefore, the manufacture of the applicator pad **210** may include an additive manufacturing process.

The label receiving side **214** of the applicator pad may include a portion having a structure, which may be a roughened surface, which has the effect of reducing the contact surface area between the label receiving side **214** and the label **212**. The portion **226** may be similar to or the same as the portion **26** of the applicator pad **10** described above, and may have any or all of the features of the portion **26**.

The second side **216** of the applicator pad **210** may include one or more stiffening ribs **230**. The ribs **230** may be provided in a grid arrangement, for example, or another advantageous arrangement, for example a honeycomb, or triangular arrangement. The arrangement of the ribs **30** may be selected to provide optimum torsional stiffness. The arrangement of the ribs **230** may be configured in accordance with the position of the or each distribution conduit **208** or some of the distribution conduits **208**, and/or the distribution chamber **206**. The or each rib **230** may have any or all of the features of the or each rib **30** of the applicator pad **10**.

In order to facilitate the manufacture of embodiments of the applicator pad **10**, a parametric computer aided design (CAD) model may be provided to create instructions for an additive manufacturing method. Entering the desired applicator pad width W and length L into the model will generate instructions to produce all of the features of the applicator pad **210**. It may be possible for a designer to select whether to include optional features.

In use, a label **12** is transported away from a printhead of a printing apparatus, typically by motor-driven spools which wind a carrier web **15** bearing a series of labels **12**, **13** in the required direction, and each label **12**, **13** is separated from the carrier web **15**, for example by a peel-off roller. As the label **12** is removed from the carrier web **15**, the label **12** travels towards the label entrance edge **218** of the applicator pad **210**. The leading edge **12***a* of the label **12** is separated from the carrier web **15** before the trailing edge **12***b*, and the leading edge **12***a* of the label **12** engages with the label receiving side **214** of the applicator pad **210** before the trailing edge **12***b* of the label **12** has been separated from the carrier web **15**.

As the label **12** moves across the label receiving side **214** of the applicator pad **210** in the direction of arrow B, at least a part of the label **12** covers an increasing proportion of the inlet **224** of the applicator pad **210**. As the inlet **224** is covered, air is then sucked through at least a part of the conduit arrangement **220**. As the label **12** continues to travel in the direction of arrow B, the conduit arrangement **220** is progressively covered, and air is then sucked through an uncovered part or parts of the conduit arrangement **220**. This arrangement means that as the label **12** moves across the applicator pad **210**, the effective air inlet (i.e. the part or parts of the air inlet **224** and/or the conduit arrangement **220** which is/are uncovered at a given moment) moves further away from the label entrance edge **218** of the applicator pad **210**. This enables the transfer of labels having a range of sizes by the same applicator pad **210**. The largest label **12** which can be handled by the applicator pad is determined by the physical size of the applicator pad **210**, and the smallest label size may be defined by a rectangular area defined by the outermost conduits **220** and may be approximately two thirds of the length (measured from the label entrance edge **218** towards the opposite edge **219**) and two third of the width W (symmetric about a centreline of the applicator pad **10**) of the label receiving side **214** of the applicator pad **210**. Alternative arrangements of the applicator pad **210** and the conduit arrangement **220** may be selected, and the optimum arrangement may be selected based upon the size of the labels intended to be printed by the printing apparatus with which the applicator pad **210** is intended to be used.

The applicator pad **210** is manoeuvred into the desired position to apply the label, by an actuator, which may be the same as or similar to the actuator **180**. The distance between the applicator pad **210** and the item to which the label is to be applied may be between approximately 0 mm and approximately 100 mm, for example, but more typically between approximately 0 mm and approximately 20 mm. The smaller the distance between the label **12** and the surface to which the label is to be applied, the greater the positional accuracy when placing the label.

Fluid, typically air, is introduced to the applicator pad **210**, via the port **202**, and may be forced through the or each nozzle **209**, for example via the distribution chamber **206** and/or the of each distribution conduit **208**. The movement of fluid through the or each nozzle **209** pushes the label **12** away from the label receiving side **214** of the applicator pad **210** towards the surface to which the label is to be applied. The label **12** may be applied to the surface without a tamp process, i.e. the blow process may be sufficient to cause the label **12** to adhere to the surface in a desired position.

It will be appreciated that there may be situations where a tamp process is acceptable, but where as light an impact force as possible is desirable. There may also be situations where the ability to apply a variable impact force is desirable.

It is desirable to apply labels with a controlled and/or repeatable impact energy and/or impact force. It may also be desirable to have a short 'cycle' time, in other words, to make the time taken to apply each label as short as possible.

A labelling apparatus includes an applicator pad (which may or may not be similar to or the same as the applicator pad **10**, **210**) for receiving a label **12**, **13** from a printing apparatus, an actuator (which may or may not be similar to or the same as the actuator **180**) to which the applicator pad is attached, for enabling movement of the applicator pad. The actuator may include a first motor **301**. The motor **301** may be coupled to the actuator via a drive belt **302** which converts rotary motion of the motor **301** to linear motion of the actuator **180**, **400**, **500**. A drive belt tensioner **304** may be provided to maintain an acceptable tension in the drive belt **302**.

A control system for controlling the movement of at least a part of a labelling apparatus may be provided. The control system may include a motor control system. The motor control system may include a first motor (e.g. **301**) for controlling movement of an actuator (e.g. **180**, **400**, **500**) which may enable movement of an applicator pad. The applicator pad may be similar to or the same as the applicator pad **10**, **210**, and or may include features of either or both of the applicator pads **10**, **210**.

The motor control system may include a closed-loop control system. The motor control system may include a position encoder mounted on a part of the first motor, for example on a rotor of the first motor. Closed-loop motor control may be achieved using sensor-less motor control technology, for example such as technology provided by Microbeam SA.

FIG. **6** shows a process diagram for the actuator motor control process. The controller is typically implemented in a microprocessor with the functionality implemented by the microprocessor software.

The motor **301** may include a stepper motor, and may include the motor itself as well as driver electronics to operate the motor **301**. It will be appreciated that similar functionality can be achieved using other electric motor types, for example a brushless DC motor or a servo motor. The motor control system enables rotor speed and position monitoring. Such monitoring may be provided as part of a 'sensorless' drive system. For other types of motor this may be derived from a rotary encoder mounted on the motor, for example. A position profile generator **307** specifies in real time a required position of the applicator pad **10**, **210**. A corresponding required position and speed of the actuator **180**, **400**, **500** are fed to a position controller **305**, which may be a closed-loop proportional controller, which uses knowledge of the current applicator position to create a speed demand for the motor **301**.

The motor control system is configured so it knows the physical parameters of the actuator **180**, **400**, **500** and pad **10**, **210** system; this includes the inertia of all moving components and the expected friction of bearing surfaces.

The physical embodiment of the motor control system may also include a gravity related component. The actuator **180**, **400**, **500** can operate in any orientation, so the motor control system may include a gravity sensor to determine the operating plane of the actuator **180**, **400**, **500**. The motor control system can then compute the expected torque the motor **301** shall deliver using standard physical model techniques. The expected torque is indicated to a speed controller **303**, which may be a closed loop Proportional/Integral controller, where it is combined with the speed demand signal to generate the motor torque demand signal which is fed to the motor itself. The use of the theoretical torque signal combined with the speed demand allows the actuator respond more quickly and precisely meaning the actuator follows the desired path more closely.

It is well known in the motor control field, when using closed loop control, that there is always a slight error between the desired speed/position and the actual speed/position. It is also known that a closed loop control system will overshoot its target speed/position. This technique reduces the error and overshoot.

FIG. **7** shows a velocity profile and a position profile of an applicator over the course of a single label application operation.

When the applicator pad has received a label **12**, **13** to be applied, the motor control system controls the first motor to move the actuator, and hence the applicator pad and the label **12**, **13** towards a desired position adjacent the surface to which the label **12**, **13** is to be applied, i.e. a first potential impact point P, the value of point P being measured as a distance from a rest position E along a motion axis of the applicator. The motor control system may move the applicator pad as quickly as possible, from the rest position E to the point P. The applicator pad arrives at the point P at a speed V. The speed V may be adjustable. The speed V may be the desired impact speed of the applicator pad against the surface to which the label **12**, **13** is to be applied.

The first motor **301** may be controlled in a position-control mode, in which the speed of the first motor **301** is determined by the position of the applicator during its movement between the rest position E and the point P. The speed profile of the applicator pad may be set dependent upon the moving mass of the applicator (plus the moving parts of the actuator) and the torque which may be provided by the first motor **301**. The speed profile may be optimised to enable the distance between the rest position E and the point P to be covered in a minimum time period. The distance between the rest position E and the point P may be a distance which is predetermined (i.e. set) and configured in the motor control system, or may be obtained from a sensor which measures the position of the applicator pad relative to the surface to which the label is to be applied (i.e. the target). A suitable sensor may be an ultrasonic distance sensor, which may be triggered by an optical sensor.

An impact zone Z may be defined as the range over which the applicator may impact the surface on which the label is to be applied. Depending on the packages being labelled and the package handling system in use there will be a range of potential impact points. Within the impact zone Z, the motor control system preferably maintains a substantially constant speed V_Z of the applicator pad. V_Z may be the speed V at which the applicator pad reaches the point P. Control parameters of the motor control system whilst the applicator pad is located within the impact zone Z may be different from the parameters applied to move the applicator pad from the rest position E to the point P. The parameters may be different in any or all of the following ways: a reduced controller stiffness, the motor control system may operate in an open-loop configuration, the motor control system may operate in a torque control mode, the motor control system may operate in accordance with a model-based feed-forward algorithm, for example to avoid a sharp increase of the motor force upon impact of the applicator pad with the target surface (which is envisaged if the motor control system is operated in accordance with a position control algorithm). An aim of the control system is to maintain the speed V_Z of the applicator pad, whilst applying a low impact force, for example a minimum impact force which is capable of applying the label **12**, **13** to the target surface. An aim is to achieve one or more of the following objectives: minimising the contact time between the applicator pad and the target surface, avoiding bouncing of the applicator pad on the target surface, and/or avoiding an application of an increased force as a result of increased motor torque during or after (for example immediately after) impact. It is possible to achieve a very soft impact by virtue of this method.

The control system may detect the impact (at an impact position D) between the applicator pad and the target surface. The control system may monitor one or more of the following impact detection parameters or a combination of two or more of the following parameters: an increase in the motor current, a deviation from the impact speed V_Z, an increase in a position error (i.e. a difference between a target position and a measured position).

When the impact is detected, the motor controller is switched back to position control mode, which may be a 'stiff' position control mode, with the target position being the impact position D, to dissipate the momentum of the first motor **301** and the transmission.

A delay may occur (which may be predetermined), during which the label **12**, **13** is applied to the target surface, before the control system moves the actuator to move the applicator pad away from the target surface, back towards the rest position E to receive a further label **12**, **13**. The control system may be operated in a position control mode, for example with an optimised motion profile to minimise the travel time between the impact position D and the rest position E. The motor control system may operate in a

similar mode to that outlined above in relation to the movement of the applicator pad between the rest position E and the point P.

The label application force may be adjusted, for example by adjusting the impact speed V_Z and/or by modifying one or more of the impact detection parameters as set out above, and/or by modifying a combination of two or more of the impact detection parameters.

The label application process can be performed repeatedly, so as to apply one or more labels to each of a series of items, for example packages in a production line. As each item approaches the vicinity of the applicator, the position of the item is determined, for example by the position sensor, which enables the impact zone Z associated with each item to be determined. Thus the impact zone Z for each item may be determined dynamically during operation of the applicator apparatus, to enable accurate control of the applicator apparatus.

A labelling apparatus may include an actuator, for enabling movement of an applicator pad towards a surface to which a label is to be applied.

Typical actuators for labelling apparatus are either pneumatically or electrically operated. 'Off-the-shelf' actuators, which may be manufactured from aluminium and/or steel are typically used in labelling apparatus to move the applicator pad towards and away from the target surface (i.e. the surface to which a label is to be applied) and may be used to apply labels to the target surface. Known actuators are typically bulky and or heavy, which tends to affect movement speeds, and inertia of the actuator and hence the applicator pad (which is attached to a part of the actuator).

An example of a part of a linear actuator **400** in accordance with embodiments of the invention is shown in FIGS. **8** and **9**. The actuator **400** includes a first arm **402**. The first arm **402** may be substantially hollow. The first arm **402** may be extruded. The first arm **402** may be manufactured from lightweight material(s), for example aluminium alloy, plastic, fibre-reinforced plastic or a pultruded composite. The first arm **402** may have a cross-sectional shape which is configured to provide mechanical robustness and/or stiffness. The first arm **402** may be manufactured as a tube or tubes.

The first arm **402** may have a shape, for example an internal shape, which is effective in guiding fluid, for example air which is used to hold and/or apply a label. The arm **402** may include a first passage **404** through which fluid, for example compressed air, may travel, for example towards an applicator pad which may be attached to the arm **402**, to blow a label **12**, **13** away from the applicator pad towards a target surface. The applicator pad may have any or all of the features of the applicator pad **10**, **210**. The arm **402** may have a second passage **406** through which fluid, for example air, may travel, for example away from the applicator pad, so as to provide suction to hold a label against the applicator pad prior to application of the label **12**, **13** to the target surface.

The arm **402** may have a shape, for example an external shape, which is configured to engage with one or more guide members **408**. The or each guide member **408** may be a wheel, roller or bearing, for example. The arm **402** may include a track portion **410** for receiving the or each guide member **408**. The track portion **410** may be a formation in an external surface of the arm **402**.

The actuator **400** may include a second arm **403**. A part of the first arm **402** may fit inside the second arm **403**, such that the actuator **400** includes a telescopic part. The second arm **403** may include any or all of the features of the first arm **402**.

The applicator pad (for example the applicator pad **10**, **210**) may be attached to the first arm **402** or the second arm **403**, in other words to the inside arm or the outside arm.

The actuator **400** is mounted to and/or supported by a body **422** which may be a part of the labelling apparatus and/or another part a production/packaging line, for example a printing apparatus. One or more bearings **424** may be provided to enable movement between the body **422** and a part of the actuator **400**, for example the first arm **402**. The or each guide member **408** may engage with a part of the body **422** and or one or more of the or each bearing **424**.

Air supply components **420**, for example fans, valves, etc., are carried by a static part of the actuator **400**, to maintain low mass of the moving part(s) of the actuator **400**. In embodiments, the air supply components **420** may be attached to, carried by or housed by the first arm **402** or the second arm **403**.

The air supply components **420** may be attached to, carried by or housed in the arm **402**, **403** which is attached to the body **422**.

An alternative embodiment of an actuator in accordance with embodiments of the invention is shown in FIG. **11**, for example. The actuator **500** may be a rotary actuator. The actuator **500** includes a body **530**. The body **530** may be a static part of the actuator **500** and may be attached to, carried by or housed by a part of the labelling apparatus and/or another part of a production/packaging line, for example a printing apparatus. Air supply components **520**, for example fans and/or valves, may be attached to, carried by or housed by the body **530**.

The arm **502** may carry an applicator pad, for example an applicator pad **10**, **210**. The applicator pad may be attached to an attachment member **534**.

The arm **502** may include any or all of the features of the arm **402**. The arm **502** may be manufactured from lightweight materials, for example aluminium alloy, plastic, fibre-reinforced plastic, and/or pultruded composite.

The actuator **500** also includes an arm **502** which may be pivotably attached to the body **530**. The arm **502** may be attached to the body **530** by a rotary union **532**. The rotary union **532** may provide fluid communication between the body **530** and the arm **502**, to enable the flow of fluid, for example air (for example as shown by arrows in FIG. **10**) to hold a label **12**, **13** adjacent the applicator pad.

The actuator **180**, referred to above, may include any or all of the features described in relation to the actuator **400**, **500**. The actuator **180**, **400**, **500** may be used in combination with any or all of the other features of the labelling apparatus described herein.

An advantage of the actuator **180**, **400**, **500** is that it is lightweight, resulting in very low inertia compared to existing actuators. This enables high speed movement of the actuator **180**, **400**, **500** (and therefore the applicator pad) resulting in a quicker labelling process. Furthermore, the actuator **180**, **400**, **500** consumes less energy to carry out a label application process as a result of its lightness. The reduction of the moving mass compared to known actuators enables the use of smaller, high-torque motors with low inertia, for example stepper motors. A single motor may be used to drive the arms **403**, **502**, for example by means of a toothed belt, which may provide a low inertia transmission. A motor rotor position sensor which may form part of the motor control system will have a direct relationship to the position of the applicator pad, enabling the motor rotor

position sensor to be used as a position sensor providing actuator/pad position feedback to the applicator control system. The motor rotor position sensor may be a rotary encoder attached to the motor or it may be part of a sensorless drive system such as that manufactured by Microbeam SA. The actuator **180**, **400**, **500** is robust—there is no mobile cabling and/or pneumatic tubing, for example. The ability to include the air flow generator as a part of the applicator apparatus, for example on a part of the actuator **180**, **400**, **500**, means that it is not necessary to utilise pressurised air from a factory-based compressor (i.e. "factory air"). The air flow generated and/or used in the applicator apparatus may be provided at a low pressure, for example up to 1000 Pa, which is significantly lower than typical "factory air" pressures, which may be in the region of 10 bar or 1 MPa, and have to be transferred to the applicator apparatus from a remote compressor (or other generator). The applicator apparatus of the present invention does not require connection to a separate air compressor, and so it may be used in any setting as required. It does not have to be compatible with any existing pneumatic arrangements which may already be present in the location where the apparatus is installed. The actuator **180**, **400**, **500** is safe, as a result of low static force and low kinetic energy of any moving components. The actuator is capable of providing a controlled impact—from a very soft impact (low force, e.g. 5 N) to a very high impact (large force, e.g. 50 N, but potentially as high as 150 N, although such a high force is unlikely to be required in practice). An ideal impact force may be 18 N. Known actuators are not capable of such soft or controlled impacts owing to their mass, and hence their inertia.

The actuators **180**, **400**, **500** may be used in combination with any of the applicator pads described herein and/or shown in the Figures.

It is desirable to be able to determine when a label is adjacent an applicator pad of a labelling apparatus. In known labelling apparatus, proximity sensors are typically mounted on the applicator pad, to detect the presence of a label. Existing label sensors typically use an optical detector system which includes an optical emitter/detector arrangement, wherein the detector detects light emitted from the emitter which has been reflected by a label. This is a costly option since it is necessary to provide flexible electrical connections to the moving end of the actuator.

FIGS. **13**A and **13**B show an embodiment of a label detection apparatus **600**, which may be used in a label detection method. It will be understood that the label detection apparatus **600** and method may be used in conjunction with any appropriate actuator and/or applicator pad.

The label detection apparatus **600** includes an air flow generator **620**, for example a fan. Other sources of air flow may be used. The air flow generated by the air flow generator **620** creates suction which holds a label **12**, **13** adjacent the applicator pad **10**, **210**. Other types of applicator pad may be used, however the features of the applicator pad **10**, **210** may be advantageous. The structure of the actuator **180**, **400**, **500**, for example an arm **402**, **502** may provide an air flow passage **602** (as described above, for example). The air flow passage **602** may have a relatively large cross-sectional area. The air flow passage **602** may extend between an inlet **624** and the air flow generator **620**.

An air flow sensor **636** may be provided to measure air flow in the air flow passage **602**. The air flow sensor **636** may be a differential pressure sensor which is capable of measuring pressure on either side of an obstruction **638** in the air flow passage **602**. The obstruction **638** may create turbulence in the air flow in the air flow passage **602**. The obstruction may be formed such that it narrows the cross-sectional area of the air flow passage **602**. The obstruction may be configured to create a 'Venturi' effect within the air flow passage **602**. Additionally or alternatively, the air flow sensor **636** may measure pressure in the air flow passage **602** with respect to an ambient pressure. The air flow sensor **636** may measure total pressure in the air flow passage **602** with respect to an ambient pressure. The ambient pressure may be the pressure outside of the air flow passage **602**. The pressure in the air flow passage **602** may be determined by a Pitot tube **637**. The Pitot tube **637** may include a slender tube having a first opening and a second opening. The first opening may be placed in the air flow passage **602** and may measure a stagnation pressure (the total pressure). The second opening may be positioned outside the air flow passage **602** to measure a static pressure (the ambient pressure); the difference between the stagnation pressure and the ambient pressure may give a value for dynamic pressure. Thus, the dynamic pressure may be determined by the air flow sensor **636**. Usage of the Pitot tube **637** may be advantageous, since the Pitot tube **637** may have a diameter that may be significantly smaller than the air flow passage **602**, thus turbulence caused by the Pitot tube **637** may be negligible. The first opening of the Pitot tube **637** may be positioned adjacent a wall of the air flow passage **602**. The position of the Pitot tube may be selected so as to minimise or reduce turbulence in the fluid in the air flow passage **602** caused by the presence of the Pitot tube **637**. The first opening of the Pitot tube **637** may be positioned in the air flow passage such that it is spaced from the inlet **624**. The first opening of the Pitot tube may be closer to the air flow generator **620** than the inlet **624**.

The air flow sensor **636** may include a diaphragm, and may be of a kind manufactured by Honeywell. The air flow sensor **636** may be a bypass-based sensor, and may be of a kind manufactured by Sensiron™.

The air flow sensor **636** may be provided on a static part of the actuator **180**, **400**, **500**. Positioning the air flow sensor **636** on a static part of the actuator **180**, **400**, **500** eliminates the requirement to provide flexible electrical connections to the moving part of the actuator **180**, **400**, **500**.

In use, the air flow generator creates an air flow in the air flow passage **602**. The air flow sensor **636** monitors air flow in the air flow passage **602**. The obstacle **638** creates a local disturbance in the air flow, such that there is a difference in the air pressure on either side of the obstacle **638**. Alternatively, the Pitot tube **637** measures the stagnation pressure (the total pressure) in the air flow passage **602** and the static pressure (the ambient pressure). The air flow sensor **636** measures the total pressure with respect to the ambient pressure (the dynamic pressure).

When a label **12**, **13** is approaching the applicator pad **10**, **201** or is positioned adjacent the applicator pad **10**, **210**, the inlet **624** is blocked by the label **12**, **13** such that air flow through the air flow passage **602** is inhibited or prevented. The air flow sensor **636** detects a reduction in or loss of air flow in the air flow passage **602**, which indicates that a label **12**, **13** is nearing the applicator pad **10**, **210**, or is adjacent the applicator pad **10**, **210**. It is possible to measure the air flow at any location in the air flow passage **602** to determine the presence of a label **12**, **13**. It is possible to measure the air flow at a position in the air flow passage **602**, which is distant from the applicator pad **10**, **210**. It is possible for the presence of a label to be detected by a sensor which is positioned on or in a static part of the actuator or other part

of the labelling apparatus. It is possible to use this method in any kind of actuator, for example linear or rotary actuators.

It is possible to detect labels **12**, **13** irrespective of the optical properties of the label **12**, **13**. For example it may be possible to detect transparent labels. The label detection apparatus is robust against pollution, for example debris which can obstruct an optical system and give false results. It is not necessary to have electrical cables and/or tubes connected to the moving part of the actuator and/or the applicator pad, which reduces the risk of damage and/or failure, and simplified maintenance and/or replacement of components of the label detection apparatus **600**. This also means that the moving part(s) of the actuator **180**, **400**, **500** are lightweight compared with existing actuators, thus providing or maintaining the advantages described above in relation to the lightness of the actuators **400**, **500**.

The less turbulence caused or created in the fluid in the air flow passage **602**, the more accurate the measurement of pressure, and hence the more accurate the determination of air flow, and the more accurate the determination of whether a label is present at or near the inlet **624**. The less turbulent the air flow in the air flow passage **602**, the better the signal to noise ratio in measurement data used to determine the presence or absence of a label. Use of the Pitot tube **637** is advantageous in reducing or minimising turbulence in the air flow in the air flow passage **602**. Therefore use of a Pitot tube **637** as the air flow sensor **636** may be particularly advantageous. The configuration (for example dimensions) and position of the Pitot tube **637** may be selected so as to optimise the ability to determine the presence or absence of a label. This optimisation may be performed by optimising or minimising the effect of the presence of the Pitot tube on the turbulence in the air flow in the air flow passage **602**.

The label detection apparatus **600** and the label detection method described herein may be used in conjunction with any or all of the other features and/or components of the labelling apparatus described herein and/or shown in the Figures.

Representative features are set out in the following clauses, which stand alone or may be combined, in any combination, with one or more features disclosed in the text and/or drawings of the specification.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Although certain example embodiments of the invention have been described, the scope of the appended claims is not intended to be limited solely to these embodiments. The claims are to be construed literally, purposively, and/or to encompass equivalents.

CLAUSES

1. An applicator apparatus including an applicator pad and an actuator for positioning the applicator pad in a desired position, the applicator pad being attached to the actuator by an attachment member, wherein the attachment member enables articulation between the applicator pad and the actuator.
2. An applicator apparatus according to clause 1 wherein a part of the attachment member is arranged to slidably engage with a part of the applicator pad.
3. An applicator apparatus according to clause 1 or clause 2 wherein the attachment member includes an engagement member which is arranged to engage with an engagement formation of the applicator pad in a dovetail arrangement.
4. An applicator apparatus according to any of the preceding clauses wherein the attachment member and the applicator pad are configured to snap-fit with one another.
5. An applicator apparatus according to any of the preceding clauses including a locking formation for locking the applicator pad in attachment with the actuator.
6. An applicator apparatus according to clause 1 or clause 2 wherein the attachment member includes a universal joint.
7. An applicator apparatus according to any of the preceding clauses wherein the attachment member enables pneumatic coupling between the applicator pad and the actuator.
8. An applicator apparatus according to any of the preceding clauses including an air flow generator.
9. An applicator apparatus according to clause 8 wherein the air flow generator is carried by a part of the actuator.
10. An applicator apparatus according to clause 8 or clause 9 wherein the air flow generator is located on a stationary part of the applicator apparatus.
11. An applicator apparatus according to any of clauses 8 to 10 wherein the air flow generator is operable to produce an air flow with an air pressure of up to approximately 1000 Pa.
12. An applicator apparatus according to any of the preceding clauses wherein, the applicator pad has a first, label receiving side and a second side, a label entrance edge and an opposite edge, a fluid inlet and a fluid conduit arrangement which is fluidly communicable with the fluid inlet to deliver fluid from the fluid inlet to a plurality of positions on the first label receiving side.
13. An applicator apparatus according to clause 12 where dependent upon any of clauses 8 to 11, wherein the fluid inlet of the applicator pad is fluidly communicable with the air flow generator via the attachment member.
14. An applicator apparatus according to clause 12 or 13 wherein the fluid inlet is positioned near to the label entrance edge of the applicator pad and at least a part of the conduit arrangement extends away from the label entrance edge of the applicator pad towards the opposite edge of the applicator pad.
15. An applicator apparatus according to any of clauses 12 to 14 wherein the fluid conduit arrangement includes a plurality of conduits.
16. An applicator apparatus according to clause 15 wherein two or more of the plurality of conduits include respective portions which are substantially parallel with one another.
17. An applicator apparatus according to any of clauses 12 to 16 wherein the cross-sectional area of the fluid inlet is approximately 25% to 75% of the area of the applicator pad, and is preferably approximately 50% of the area of the applicator pad.
18. An applicator apparatus according to any of clauses 12 to 17, wherein the label receiving side of the applicator pad includes a portion having a roughened surface, the portion covering at least a part of the first, label receiving side of the applicator pad.

19. An applicator apparatus according to clause 18 wherein the roughened surface is provided by an additive manufacturing process and/or a moulding process.
20. An applicator apparatus according to any of the preceding clauses wherein the applicator pad includes one or more stiffening ribs.
21. An applicator apparatus according to any of the preceding clauses, where dependent upon any of claims **12** to **20**, wherein the applicator pad includes one or more nozzles terminating at or near the label receiving side of the applicator pad, the or each nozzle being fluidly communicable with a pressurised fluid source.
22. An applicator apparatus according to clause 21 where dependent upon any of clauses 8 to 11, wherein the pressurised fluid source is the air flow generator.
23. An applicator apparatus according to clause 21 or clause 22 including a plurality of nozzles, at least some of which are fluidly communicable with the source of pressurised fluid via a distribution chamber.
24. An applicator apparatus according to any of clauses 21 to 23 including at least one opening in the label side of the applicator pad, the or each opening being associated with a corresponding nozzle.
25. An applicator apparatus according to clause 24 wherein each opening surrounds the corresponding nozzle.
26. An applicator apparatus including an applicator pad for applying a label to an item, an air flow generator, an air guide for guiding the air flow between the air flow generator and the applicator pad, and a label detector for detecting the presence of a label adjacent the applicator pad, wherein the label detector includes a flow sensor for measuring air flow at a location between the air flow generator and the applicator pad.
27. An applicator apparatus according to clause 26 wherein the flow sensor is a differential pressure sensor.
28. An applicator apparatus according to clause 27 wherein the air guide includes an obstacle, and the differential pressure sensor measures air pressure on both sides of the obstacle.
29. An applicator apparatus according to any of clauses 1 to 25 and being further dependent upon any of clauses 26 to 28.
30. An actuator for an applicator apparatus, the actuator being operable to position an applicator pad in a desired position relative to an item to which a label is to be applied, the actuator including one of an extruded or pultruded body to which the applicator pad is connectable.
31. An actuator according to clause 30 including at least two telescopic bodies.
32. An actuator according to clause 30 or 31 wherein the actuator body enables fluid communication between the applicator pad and a source of pressurised fluid and/or an air flow generator.
33. An actuator according to any of clauses 30 to 32 including at least one bearing member which is engageable with a part of a label printing apparatus to facilitate movement of at least a part of the actuator relative to the part of the label printing apparatus.
34. An actuator according to clause 33 wherein the or each bearing member is a roller.
35. An applicator apparatus including an actuator according to any of clauses 30 to 34.
36. An applicator apparatus according to any of clauses 1 to 29 including an actuator according to any of clauses 30 to 35.
37. A method of controlling an applicator apparatus including an applicator pad for applying a label to an item, an actuator for positioning the applicator pad in a desired position relative to an item, and a control system for controlling movement of the actuator, the control system including at least one motor, the method including determining a desired position of the applicator pad, determining a required speed of the actuator to achieve the desired position of the applicator pad, taking into account at least one physical parameter of the actuator and/or the applicator pad, and calculating a motor torque required to achieve the desired position of the applicator pad, taking into account a current position of the applicator pad.
38. A method of controlling an applicator apparatus according to clause 37 including determining an impact of the applicator pad with the item by detecting one or more of an increase in motor current, a change in speed of movement of the actuator and an increase in a difference value between the desired position of the applicator pad and an actual position of the applicator pad.
39. A method according to clause 37 or clause 38 wherein an impact zone is determined, and the control system operates under different conditions when the actual position of the applicator pad is determined to be within the impact zone.
40. A method of controlling an applicator apparatus according to clause 39, for applying a label to each of a series of items, wherein the control system is operable to determine a respective impact zone associated with each item to which a label is to be applied.
41. A method according to clause 39 or clause 40 including reducing control stiffness, and/or operating the motor in an open-loop torque mode and/or utilising a model-based feed-forward algorithm to control the motor when the applicator pad is determined to be in the impact zone.
42. A method according to any of clauses 37 to 41 including adjusting the control parameters of the control system in response to detecting a collision between the applicator pad and the item.

The invention claimed is:

1. An applicator apparatus including an applicator pad and an actuator for positioning the applicator pad in a desired position, the applicator pad being attached to the actuator by an attachment member, wherein the attachment member enables articulation between the applicator pad and the actuator, and wherein the attachment member enables pneumatic coupling between the applicator pad and the actuator.

2. An applicator apparatus according to claim **1** wherein a part of the attachment member is arranged to slidably engage with a part of the applicator pad, and/or wherein the attachment member includes an engagement member which is arranged to engage with an engagement formation of the applicator pad in a dovetail arrangement, and/or wherein the attachment member and the applicator pad are configured to snap-fit with one another, and/or wherein the applicator apparatus includes a locking formation configured to receive a locking member to lock the applicator pad in attachment with the actuator.

3. An applicator apparatus according to claim **1** wherein the attachment member includes a universal joint.

4. An applicator apparatus according to claim **1** including an air flow generator and optionally wherein the air flow generator is carried by a part of the actuator or alternatively wherein the air flow generator is located on a stationary part of the applicator apparatus.

5. An applicator apparatus according to claim 4 wherein the air flow generator is configured to produce an air flow with an air pressure of up to approximately 1000 Pa.

6. An applicator apparatus according to claim 1 wherein, the applicator pad has a first, label receiving side and a second side, a label entrance edge and an opposite edge, a fluid inlet and a fluid conduit arrangement which is fluidly communicable with the fluid inlet to deliver fluid from the fluid inlet to a plurality of positions on the first label receiving side.

7. An applicator apparatus according to claim 6, including an air flow generator and wherein the fluid inlet of the applicator pad is fluidly communicable with the air flow generator via the attachment member.

8. An applicator apparatus according to claim 7 wherein the fluid inlet is positioned adjacent the label entrance edge of the applicator pad and at least a part of the conduit arrangement extends away from the label entrance edge of the applicator pad towards the opposite edge of the applicator pad, and/or wherein the fluid conduit arrangement includes a plurality of conduits.

9. An applicator apparatus according to claim 8 wherein two or more of the plurality of conduits include respective portions which are substantially parallel with one another.

10. An applicator apparatus according to claim 6 wherein the cross-sectional area of the fluid inlet is approximately 25% to 75% of the area of the applicator pad, and is preferably approximately 50% of the area of the applicator pad, and/or wherein the label receiving side of the applicator pad includes a portion having a roughened surface, the portion covering at least a part of the first, label receiving side of the applicator pad, and optionally the roughened surface is provided by an additive manufacturing process and/or a moulding process.

11. An applicator apparatus according to claim 1 wherein the applicator pad includes one or more stiffening ribs.

12. An applicator apparatus according to claim 6, wherein the applicator pad includes one or more nozzles terminating adjacent the label receiving side of the applicator pad, the or each nozzle being fluidly communicable with a pressurised fluid source.

13. An applicator apparatus according to claim 12 including an air flow generator, wherein the pressurised fluid source is the air flow generator, and/or including a plurality of nozzles, at least some of the plurality of nozzles being fluidly communicable with the source of pressurised fluid via a distribution chamber, and/or including at least one opening in the label side of the applicator pad, the or each opening being associated with a corresponding nozzle and optionally wherein each opening surrounds the corresponding nozzle.

14. An applicator apparatus including an applicator pad for applying a label to an item, an air flow generator, an air guide configured to guide the air flow between the air flow generator and the applicator pad, and a label detector configured to detect the presence of a label adjacent the applicator pad, wherein the label detector includes a differential pressure sensor configured to measure air flow at a location between the air flow generator and the applicator pad.

15. An applicator apparatus according to claim 14 wherein the air guide includes an obstacle, and the differential pressure sensor measures air pressure on both sides of the obstacle.

16. An actuator for an applicator apparatus, the actuator being operable to position an applicator pad in a desired position relative to an item to which a label is to be applied, the actuator including one of an extruded or pultruded actuator body to which the applicator pad is connectable.

17. An actuator according to claim 16 including at least two telescopic bodies, and/or wherein the actuator body enables fluid communication between the applicator pad and a source of pressurised fluid and/or an air flow generator, and/or wherein the actuator includes at least one bearing member which is engageable with a part of a label printing apparatus to facilitate movement of at least a part of the actuator relative to the part of the label printing apparatus and optionally wherein the or each bearing member is a roller.

18. An applicator apparatus including an actuator according to claim 16.

19. A method of controlling an applicator apparatus including an applicator pad for applying a label to an item, an actuator for positioning the applicator pad in a desired position relative to an item, and a control system for controlling movement of the actuator, the control system including at least one motor, the method including determining a desired position of the applicator pad, determining a required speed of the actuator to achieve the desired position of the applicator pad, taking into account at least one physical parameter of the actuator and/or the applicator pad, and calculating a motor torque required to achieve the desired position of the applicator pad, taking into account a current position of the applicator pad.

20. A method of controlling an applicator apparatus according to claim 19 including determining an impact of the applicator pad with the item by detecting one or more of an increase in motor current, a change in speed of movement of the actuator and an increase in a difference value between the desired position of the applicator pad and an actual position of the applicator pad.

21. A method according to claim 19 wherein an impact zone is determined, and the control system operates under different conditions when the actual position of the applicator pad is determined to be within the impact zone, and optionally when applying a label to each of a series of items, wherein the control system is operable to determine a respective impact zone associated with each item to which a label is to be applied, and optionally including reducing control stiffness, and/or operating the motor in an open-loop torque mode and/or utilising a model-based feed-forward algorithm to control the motor when the applicator pad is determined to be in the impact zone.

22. A method according to claim 19 including adjusting the control parameters of the control system in response to detecting a collision between the applicator pad and the item.

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